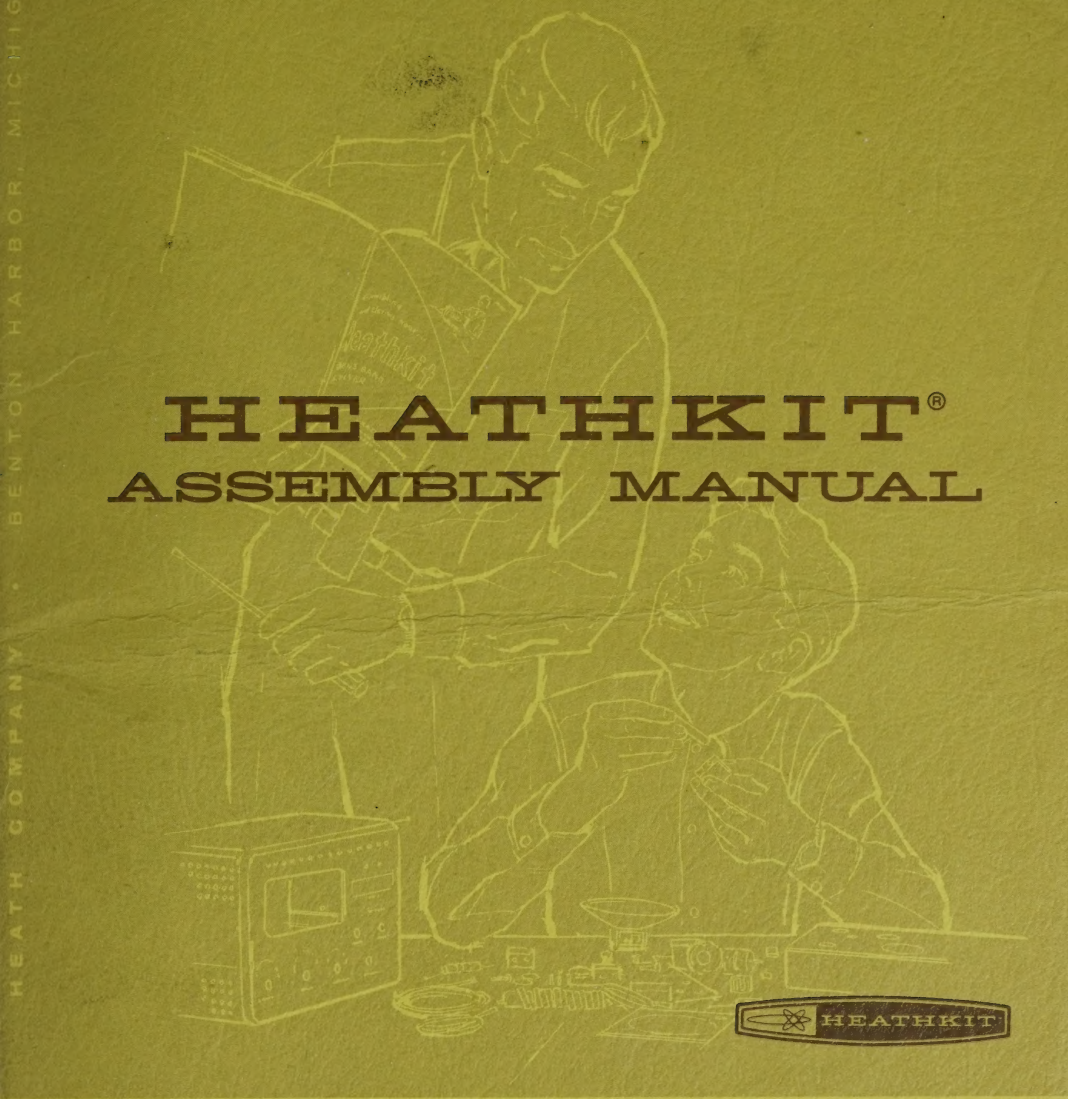
PRICE $2.00

HEATH COMPANY • BENTON HARBOR, MICHIGAN



HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT

VACUUM TUBE VOLTMETER

AUDIO

MODEL IM-38

595-990-02

Dear Customer:

You have just purchased one of the best performing electronic products in the world — your Heathkit.

Here's how we aim to keep it that way:

Your Heathkit Warranty

During your first 90 days of ownership, any parts which we find are defective, either in materials or workmanship, will be replaced or repaired free of charge. And we'll pay shipping charges to get those parts to you — anywhere in the world.

If we determine a defective part has caused your Heathkit to need other repair, through no fault of yours, we will service it free — at the factory, at any retail Heathkit Electronic Center, or through any of our authorized overseas distributors.

This protection is exclusively yours as the original purchaser. Naturally, it doesn't cover damage by use of acid-core solder, incorrect assembly, misuse, fire, flood or acts of God. But, it does insure the performance of your Heathkit anywhere in the world — for most any other reason.

After-Warranty Service

What happens after warranty? We won't let you down. If your Heathkit needs repairs or you need a part, just write or call the factory, your nearest retail Heathkit Electronic Center, or any Heath authorized overseas distributor. We maintain an inventory of replacement parts for each Heathkit model at most locations — even for models that no longer appear in our current product line-up. Repair service and technical consultation is available through all locations.

We hope you'll never need our repair or replacement services, but it's nice to know you're protected anyway — and that cheerful help is nearby.

Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022

Compl. 7-8-23

Assembly
and
Operation
of the

HEATHKIT

VACUUM TUBE VOLTMETER

MODEL IM-38

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HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

SPECIFICATIONS

Frequency Response	±1 db from 10 cps to 500 kc, all ranges. ±2 db from 10 cps to 1 mc, all ranges.
Ranges	Ten ranges, marked both in volts and db.
Volts	.01, .03, .1, .3, 1, 3, 10, 30, 100, 300 volts rms full scale.
Decibels	-40, -30, -20, -10, 0, +10, +20, +30, +40, +50 db (0 db is equal to 1 milliwatt in 600 Ω).
Input Impedance	10 megohms shunted by 12 μμf on all ranges from 10 volts to 300 volts.
	10 megohms shunted by 22 μμf on all ranges from .01 volt to 3 volts.
Power Requirements	105-125 or 210-250 volts, 50/60 cps AC, 10 watts.
Dimensions	7-3/8" high x 4-11/16" wide x 4-1/8" deep.
Accuracy	Within 5% of full scale.
Net Weight	3 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

INTRODUCTION

The Model IM-38 Vacuum Tube Voltmeter is designed to measure AC voltages from 10 cycles per second to 1 megacycle. Ten switch-selected voltage ranges are provided. The full-scale readings vary from 10 millivolts for the lowest range to 300 volts for the highest. Each of these ten ranges is also calibrated in db (decibels) for your convenience.

A high input impedance (10 megohms) is provided so that the VTVM can be used to measure voltages in sensitive circuits without appreciable loading.

The VTVM normally is used to indicate repetitive AC voltages. It can also be used as a VU meter to indicate changing AC voltages, such as found in speech or music equipment. (The VU meter is a standard level meter used in broadcasting and recording equipment.)

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

CIRCUIT DESCRIPTION

It may be helpful to refer to the Schematic Diagram while reading the following description.

The circuit of this VTVM may be divided into four general sections: The input section, which consists of the input cathode follower and the input attenuators; the amplifier section; the meter circuit; and the power supply.

The input AC voltage is first applied to the frequency-compensated, 1000-to-1 voltage divider in the grid circuit of input cathode follower V1A. Input voltages for the lower six ranges are coupled directly to the grid of V1A from the top of the voltage divider. Input signals for the higher four ranges are divided by 1000 and coupled to the grid of V1A from the lower tap of the voltage divider.

The cathode follower stage, V1A, represents a high impedance to the input signal applied to its grid. The output of V1A is a low impedance source for the signal applied to the precision voltage divider which feeds the input of the amplifier section.

The precision voltage divider divides the signal from the cathode follower into the six different levels to provide ten scales, with readings from 10 millivolts to 300 volts.

The amplifier section consists of V1B, V2, and the various circuit components in these two stages. Approximately 19 db of negative feedback is returned through the meter circuit from V2 to the cathode circuit of V1B. This negative feedback provides high stability and uniform gain over the wide frequency range of the amplifier.

The meter circuit consists of a 200 microampere meter, with a full-wave bridge rectifier that uses four germanium diodes. For calibration purposes, the amount of meter current can be adjusted by means of the calibrate control. This control determines the amount of meter current by adjusting the amount of negative feedback to the cathode of V1B.

The power supply consists of a half-wave silicon rectifier circuit, and capacitor C17. The power supply also supplies filament voltage to the tubes and pilot lamp. In order to minimize hum, the filament winding of the power transformer is balanced to ground through resistors R28 and R29.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

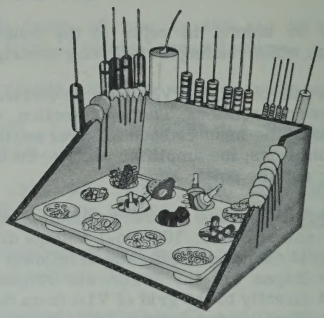
UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacement section and supply the information called for therein.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started.

1. Lay out all parts so that they are readily available.

2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.



Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.

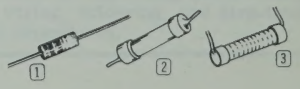
PARTS LIST

To order replacement parts, refer to the Replacement Parts Price List and use the Parts Order Form furnished with this kit.

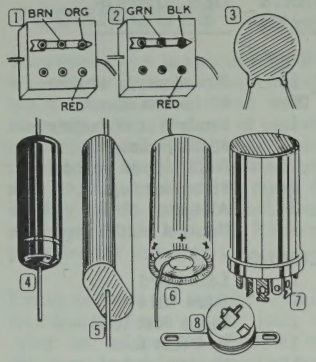
PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
(1) 1-49	1	22 Ω 1/2 watt (red-red-black)
1-103	1	33 Ω 1/2 watt (orange-orange-black)
1-1	3	47 Ω 1/2 watt (yellow-violet-black)
1-118	1	82 Ω 1/2 watt (gray-red-black)
1-3	2	100 Ω 1/2 watt (brown-black-brown)
1-13	1	2700 Ω 1/2 watt (red-violet-red)
1-20	2	10 KΩ 1/2 watt (brown-black-orange)
1-25	3	47 KΩ 1/2 watt (yellow-violet-orange)
1-60	1	68 KΩ 1/2 watt (blue-gray-orange)
1-27	1	150 KΩ 1/2 watt (brown-green-yellow)
1-33	4	470 KΩ 1/2 watt (yellow-violet-yellow)

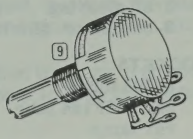
PART No.	PARTS Per Kit	DESCRIPTION
Resistors (cont'd.)		
(2) 2-159	1	100 Ω precision
2-25	1	216.2 Ω precision
2-28	1	683.8 Ω precision
2-31	1	2162 Ω precision
2-33	1	6838 Ω precision
2-39	1	21.62 KΩ precision
2-17	1	10 megohm precision
(3) 2-50	1	10 KΩ precision

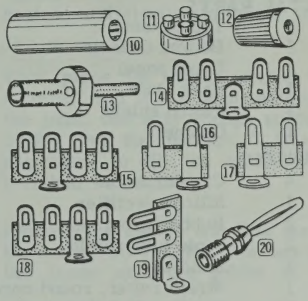
PARTS PICTORIAL

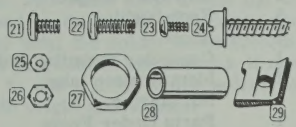


PART No.	PARTS Per Kit	DESCRIPTION
CAPACITORS		
(1) 20-71	1	.0013 μfd mica (1300 μμf)
(2) 20-75	1	.005 μfd mica (5000 μμf)
(3) 21-47	1	.01 μfd disc ceramic
21-31	1	.02 μfd disc ceramic
(4) 23-28	3	.1 μfd tubular
(5) 27-19	2	1 μfd Mylar*
(6) 25-39	3	2 μfd 150 volt electrolytic
25-95	1	10 μfd electrolytic, 25 volts
(7) 25-23	1	20-40-80 μfd electrolytic, 150 volts
(8) 31-13	1	3-12 μμf trimmer
CONTROL-SWITCH-TRANSFORMER		
(9) 11-16	1	40 Ω control
63-502	1	Range switch, 11-position
54-2-24	1	Power transformer
BINDING POSTS-TERMINALS		
(10) 70-5	1	Banana plug sleeve, black
70-6	1	Banana plug sleeve, red
(11) 75-17	4	Binding post insulator
(12) 100-16-2	1	Binding post cap, black
100-16-18	1	Binding post cap, red
(13) 427-3	2	Binding post base
(14) 431-5	1	4-lug terminal strip
(15) 431-12	1	4-lug terminal strip
(16) 431-14	1	2-lug terminal strip
(17) 431-16	3	2-lug terminal strip
(18) 431-40	1	4-lug terminal strip
(19) 431-51	1	2-lug terminal strip
(20) 438-13	2	Banana plug
HARDWARE		
(21) 250-56	12	6-32 x 1/4" screw
(22) 250-48	2	6-32 x 1/2" screw
(23) 250-49	4	3-48 x 1/4" screw
(24) 250-83	2	#10 x 1/2" handle screw
250-89	1	6-32 x 3/8" screw
(25) 252-1	4	3-48 nut
(26) 252-3	16	6-32 nut
(27) 252-7	2	Control nut
(28) 440-11	1	Plastic control guard
(29) 252-22	2	6-32 speednut



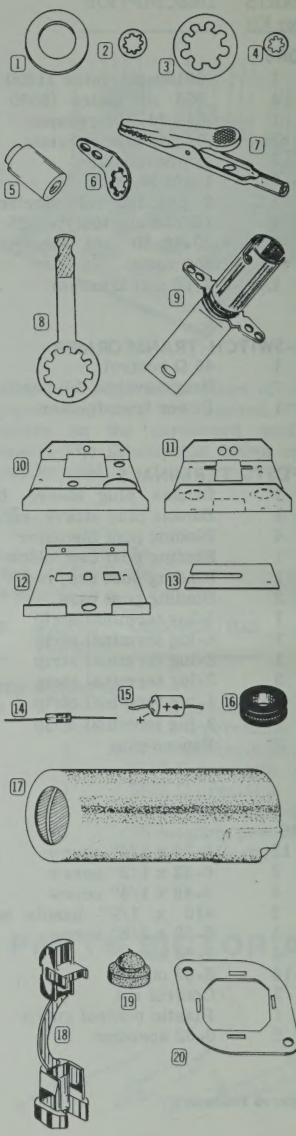






*DuPont Registered Trademark

PART No.	PARTS Per Kit	DESCRIPTION
Hardware (cont'd.)		
(1) 253-10	2	Flat control washer
(2) 254-1	21	#6 lockwasher
(3) 254-4	1	Control lockwasher
(4) 254-7	4	#3 lockwasher
(5) 255-17	1	6-32 tapped spacer
(6) 259-1	3	#6 solder lug
(7) 260-1	2	Alligator clip
(8) 259-10	1	Control solder lug
WIRE-SLEEVING		
89-23	1	Line cord
340-8	1	Bare wire
341-1	1	Black test lead
341-2	1	Red test lead
344-59	1	Hookup wire
346-1	1	Sleeving
346-6	1	3/8" sleeving
347-9	1	3-conductor shielded cable
TUBES-LAMP-SOCKETS		
411-96	1	6AW8 tube
411-160	1	6EJ7/EF184 tube
412-1	1	#47 lamp
434-43	2	9-pin tube socket
(9) 434-44	1	Pilot lamp socket
SHEET METAL PARTS		
(10) 200-309	1	Top chassis
(11) 200-310	1	Bottom chassis
203-105-3	1	Front panel
(12) 205-603	1	Back plate
(13) 206-179	1	Switch shield
90-413	1	Cabinet
MISCELLANEOUS		
(14) 56-26	4	Crystal diode
(15) 57-27	1	Silicon rectifier
(16) 73-1	2	Rubber grommet
(17) 206-54	2	9-pin tube shield
211-15	1	Handle
75-30	1	Strain relief, round cord
(18) 75-71	1	Strain relief, flat cord
(19) 261-4	4	Rubber foot
407-85	1	Meter
432-27	1	Line cord adapter
455-50	1	Knob bushing
462-245	1	Knob
(20) 481-1	1	Capacitor mounting wafer
391-34	1	Identification label
490-5	1	Nut starter
597-260	1	Parts Order Form
597-308	1	Kit Builders Guide
	1	Manual (See front cover for part number.)
		Solder



PROPER SOLDERING TECHNIQUES

Only a small percentage of HEATHKIT equipment purchasers find it necessary to return an instrument for factory service. Of these instruments, by far the largest portion of malfunctions is due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 25 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron than this may not heat the connection enough to flow the solder smoothly over the joint. Keep the iron tip clean and bright by wiping it from time to time with a cloth.

CHASSIS WIRING AND SOLDERING

1. Unless otherwise indicated, all wire used is the type with colored insulation (hookup wire); the size of the conductor is the same for all colors of hookup wires furnished with this kit. In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the construction step.

2. To avoid breaking internal connections when stripping insulation from the leads of transformers or similar components, care should be taken not to pull directly on the lead. Instead, hold the lead with pliers while it is being stripped.

3. Leads on resistors, capacitors and similar components are generally much longer than they need to be to make the required connections. In these cases, the leads should be cut to proper length before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points.

4. Wherever there is a possibility of bare leads shorting to other parts or to the chassis, the leads should be covered with insulating sleeving. Where the use of sleeving is specifically intended, the phrase "use sleeving" is included in the associated construction step. In any case where there is the possibility of an unintentional short circuit, sleeving should be used. Extra sleeving is provided for this purpose.

5. Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the wire is too large to allow bending or if the step states that the wire is not to be crimped, position the wire so that a good solder connection can still be made.

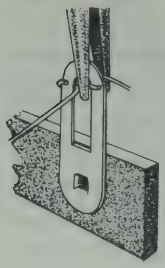
6. Position the work, if possible, so that gravity will help to keep the solder where you want it.

7. Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.

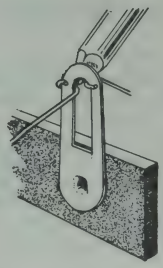
8. Then place the solder against the heated terminal and it will immediately flow over the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.

9. Remove the solder and then the iron from the completed junction. Use care not to move the leads until the solder is solidified.

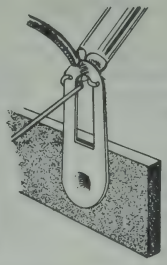
A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly over the entire junction. In some cases, it may be necessary to add a little more solder to achieve a smooth bright appearance.



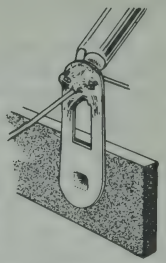
CRIMP WIRES



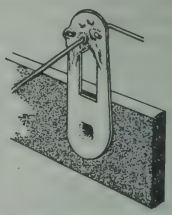
HEAT CONNECTION



APPLY SOLDER



ALLOW SOLDER TO FLOW



PROPER SOLDER CONNECTION

ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT. ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60:40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the Pictorial as it is added.

The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but, because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustrations may be slightly distorted to facilitate clearly showing all of the parts.

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a lead to lug 1 (S-2)," it will be understood that there will be two leads connected to the terminal at the time it is soldered. (In cases where a lead passes through a terminal or lug and then connects to another point, it will count as two leads, one entering and one leaving the terminal.)

The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation on the Schematic, its designation will appear at the beginning of the construction step which directs its installation.

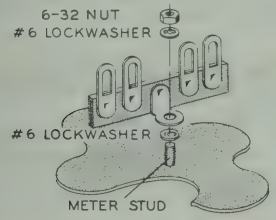
STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1 (fold-out from Page 11) for the following steps.

NOTE: Be careful not to mar the front of the meter when assembling the kit. The front of the meter can be covered with paper or some other protective material during assembly.

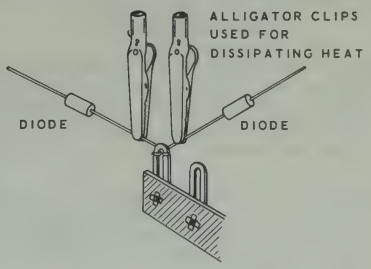
The plastic nut starter (#490-5) will help you pick up a nut and start it on the screw threads. See Page 3 of the Kit Builders Guide. Be sure to tighten the hardware after you mount a part.

( ) Mount the meter on the front panel as shown, using the brass lockwashers and nuts packed in the cellophane bag with the meter. Using an extra #6 lockwasher, mount a 4-lug terminal strip under the lower left-hand nut as shown in Detail 1A. Do not tighten the two top nuts all the way at this time as they will be removed later.



Detail 1A

CAUTION: A crystal diode can be damaged by excessive heat while soldering. To avoid damage, place an alligator clip over the lead or leads to be soldered between the body of the diode and the point to be soldered. See Detail 1B. The alligator clips will now absorb the heat; do not release them until the connection is cool.



Detail 1B

( ) Clip both leads of one of the crystal diodes to a length of 1/2". Connect the lead from the banded end of this crystal diode to lug 1 (NS) and connect the other lead to lug 2 (NS) of terminal strip A.

( ) Clip each lead of a crystal diode to a length of 1/2". Connect the lead from the banded end of this crystal diode to lug 3 (NS) and connect the other lead to lug 4 (NS) of terminal strip A.

( ) Connect one end of an 8" length of hookup wire to lug 1 of terminal strip A (NS). Leave the other end of this wire free.

( ) Connect the lead from the banded end of a crystal diode to lug 1 of the meter (NS). Connect the other lead of this crystal diode to lug 1 of terminal strip A (S-3).

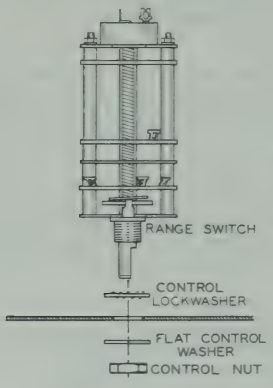
( ) Connect a 3-1/2" length of hookup wire from lug 2 of terminal strip A (NS) to lug 2 of the meter (NS).

( ) Connect a 2-1/4" length of hookup wire from lug 3 of terminal strip A (S-2) to lug 1 of the meter (NS).

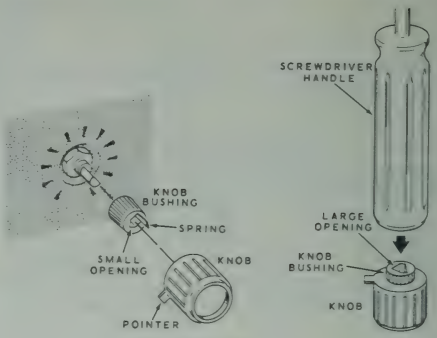
( ) C16. Connect a .1 µfd tubular capacitor between lug 1 (S-3) and lug 2 (S-2) of the meter. Be sure that the lead from the banded end of the capacitor is connected to lug 2 as shown.

( ) Place 1/2" of sleeving over each lead of a crystal diode. Connect the lead from the banded end of this crystal diode to lug 4 (NS) and connect the other lead to lug 2 (S-3) of terminal strip A.

( ) Mount the range switch on the front panel as shown in Detail 1C, using a control lockwasher, a flat control washer, and a control nut. Orient the switch as shown in Pictorial 1.



Detail 1C



Detail 1D

KNOB INSTALLATION

The knob supplied with this kit uses a knob bushing that provides permanent positive gripping without the use of setscrews.

In the following steps you will install a knob on the switch shaft as shown in Detail 1D. Perform these steps carefully since it is very difficult to remove a knob bushing from a knob once it is fully inserted.

( ) Push a knob bushing part way onto the switch shaft. Then turn the switch shaft to its full counterclockwise position.

( ) Line up the pointer of the knob with the full counterclockwise marking on the panel. Then press the knob slightly onto the knob bushing.

( ) Turn the knob clockwise to each of the switch stop positions. Check to see that the pointer lines up with each panel marking.

NOTE: Perform the next three steps only if the pointer does not line up at each switch marking.

1. ( ) Turn the knob pointer to the mid-position marking on the panel.

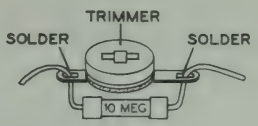
2. ( ) Remove the knob from the bushing and turn it slightly to line up the pointer with the mid-position marking.

3. ( ) Press the knob slightly onto the knob bushing. Then turn the knob to each switch position and recheck the pointer alignment. If more than a slight error is noticed at either end position, repeat these three steps.

( ) Carefully remove the knob bushing and knob together.

( ) Place the knob on a table or other hard surface, then press the knob bushing firmly into the knob. Use a towel or soft cloth on the work surface to avoid scratching the knob.

( ) Press the knob and bushing firmly onto the switch shaft.



Detail 1E

RANGE SWITCH WIRING

( ) C2, R1. Connect the 10 megohm precision resistor to the trimmer capacitor as shown in Detail 1E. Solder the leads at each end of the trimmer capacitor, but do NOT cut off the leads.

( ) Connect this trimmer-resistor combination from lug 7 (NS) to lug 8 (NS) on deck A of the range switch.

( ) Cut both leads of a .02 μfd disc ceramic capacitor to a length of 1/2". Connect one of these leads to lug 7 on deck A of the range switch (S-2). Leave the other lead free.

( ) Connect a 1" length of bare wire from lug 8 (S-2) to lug 1 (NS) on deck A of the range switch. Place this wire away from the metal parts of the switch.

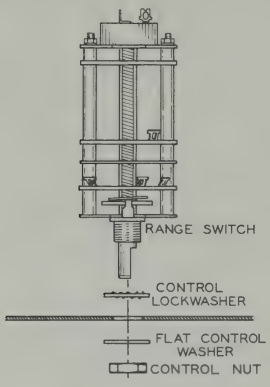
( ) C8. Cut the lead at the unbanded end of a .1 μfd tubular capacitor to a length of 3/4". Connect this lead to lug 7 on deck B of the range switch (S-1). Leave the other lead free.

( ) Connect a 2-1/4" length of hookup wire from lug 3 of terminal strip A (S-2) to lug 1 of the meter (NS).

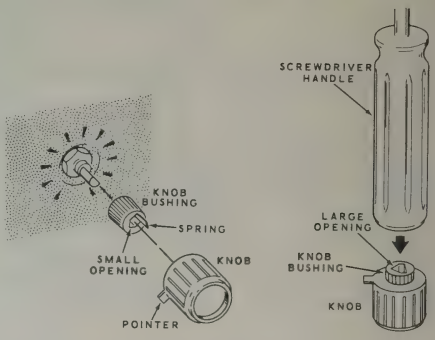
C16. Connect a .1 μfd tubular capacitor between lug 1 (S-3) and lug 2 (S-2) of the meter. Be sure that the lead from the banded end of the capacitor is connected to lug 2 as shown.

Place 1/2" of sleeving over each lead of a crystal diode. Connect the lead from the banded end of this crystal diode to lug 4 (NS) and connect the other lead to lug 2 (S-3) of terminal strip A.

Mount the range switch on the front panel as shown in Detail 1C, using a control lockwasher, a flat control washer, and a control nut. Orient the switch as shown in Pictorial 1.



Detail 1C



Detail 1D

KNOB INSTALLATION

The knob supplied with this kit uses a knob bushing that provides permanent positive gripping without the use of setscrews.

In the following steps you will install a knob on the switch shaft as shown in Detail 1D. Perform these steps carefully since it is very difficult to remove a knob bushing from a knob once it is fully inserted.

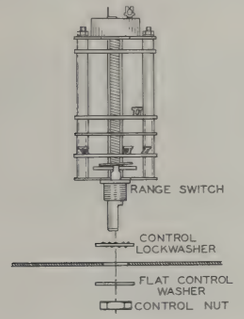
Push a knob bushing part way onto the switch shaft. Then turn the switch shaft to its full counterclockwise position.

( ) Connect a 2-1/4" length of hookup wire from lug 3 of terminal strip A (S-2) to lug 1 of the meter (NS).

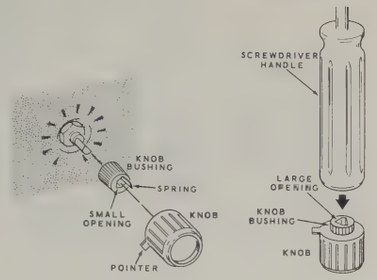
( ) C16. Connect a .1 µfd tubular capacitor between lug 1 (S-3) and lug 2 (S-2) of the meter. Be sure that the lead from the banded end of the capacitor is connected to lug 2 as shown.

( ) Place 1/2" of sleeving over each lead of a crystal diode. Connect the lead from the banded end of this crystal diode to lug 4 (NS) and connect the other lead to lug 2 (S-3) of terminal strip A.

( ) Mount the range switch on the front panel as shown in Detail 1C, using a control lockwasher, a flat control washer, and a control nut. Orient the switch as shown in Pictorial 1.



Detail 1C



Detail 1D

KNOB INSTALLATION

The knob supplied with this kit uses a knob bushing that provides permanent positive gripping without the use of setscrews.

In the following steps you will install a knob on the switch shaft as shown in Detail 1D. Perform these steps carefully since it is very difficult to remove a knob bushing from a knob once it is fully inserted.

( ) Push a knob bushing part way onto the switch shaft. Then turn the switch shaft to its full counterclockwise position.

( ) Line up the pointer of the knob with the full counterclockwise marking on the panel. Then press the knob slightly onto the knob bushing.

( ) Turn the knob clockwise to each of the switch stop positions. Check to see that the pointer lines up with each panel marking.

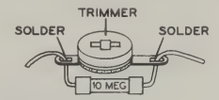
NOTE: Perform the next three steps only if the pointer does not line up at each switch marking.

1. ( ) Turn the knob pointer to the mid-position marking on the panel.
2. ( ) Remove the knob from the bushing and turn it slightly to line up the pointer with the mid-position marking.
3. ( ) Press the knob slightly onto the knob bushing. Then turn the knob to each switch position and recheck the pointer alignment. If more than a slight error is noticed at either end position, repeat these three steps.

( ) Carefully remove the knob bushing and knob together.

( ) Place the knob on a table or other hard surface, then press the knob bushing firmly into the knob. Use a towel or soft cloth on the work surface to avoid scratching the knob.

( ) Press the knob and bushing firmly onto the switch shaft.



Detail 1E

RANGE SWITCH WIRING

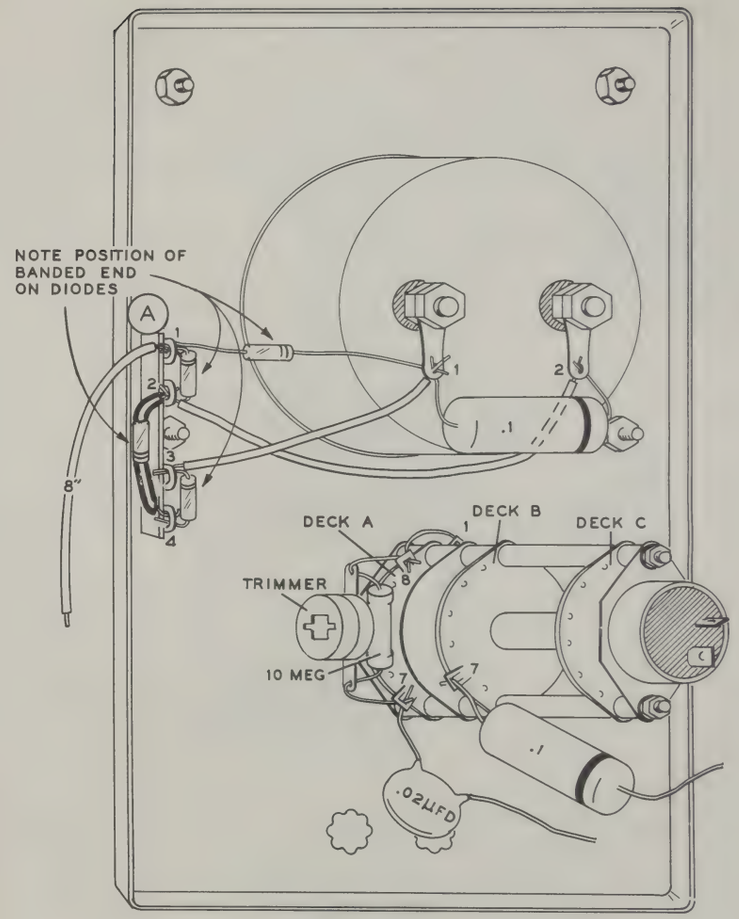
( ) C2, R1. Connect the 10 megohm precision resistor to the trimmer capacitor as shown in Detail 1E. Solder the leads at each end of the trimmer capacitor, but do NOT cut off the leads.

( ) Connect this trimmer-resistor combination from lug 7 (NS) to lug 8 (NS) on deck A of the range switch.

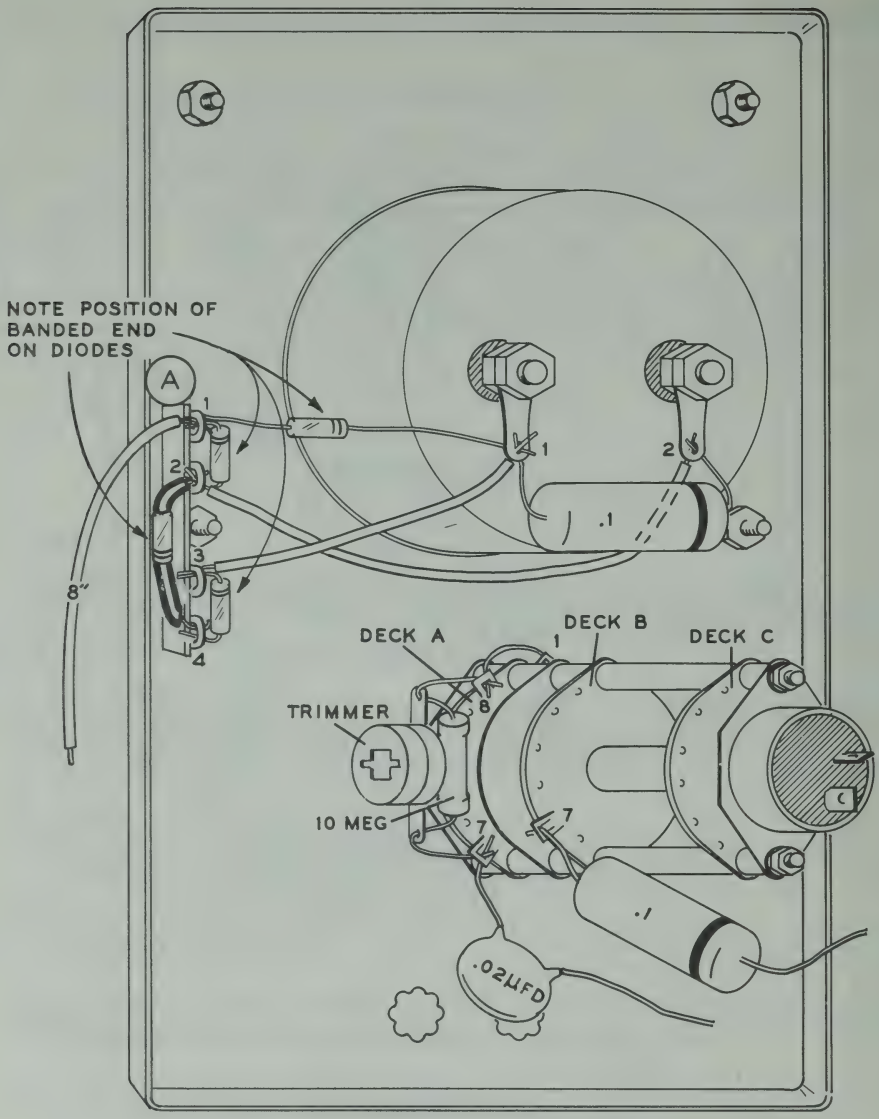
( ) Cut both leads of a .02 µfd disc ceramic capacitor to a length of 1/2". Connect one of these leads to lug 7 on deck A of the range switch (S-2). Leave the other lead free.

( ) Connect a 1" length of bare wire from lug 8 (S-2) to lug 1 (NS) on deck A of the range switch. Place this wire away from the metal parts of the switch.

( ) C8. Cut the lead at the unbanded end of a .1 µfd tubular capacitor to a length of 3/4". Connect this lead to lug 7 on deck B of the range switch (S-1). Leave the other lead free.



PICTORIAL 1


NOTE POSITION OF
BANDED END
ON DIODES
A
1
2
3
4
8"
1
2
.1
DECK A
DECK B
DECK C
1
8
TRIMMER
10 MEG
7
7
.1
.02μFD

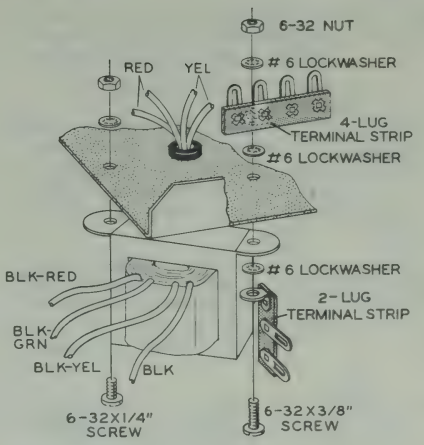
PICTORIAL 1

( ) Connect one end of a 2-1/2" length of hookup wire to lug 4 on deck A of the range switch (NS). Leave the other lead free.

( ) C4. Cut the positive (+) lead of the 10 μfd electrolytic capacitor to a length of 1". Connect this lead to lug 4 on deck A of the range switch (S-4). Leave the other lead free.

( ) R4. Place sleeving over one lead of a 47 Ω (yellow-violet-black) resistor and connect it to lug 6 on deck A of the range switch (S-1). Leave the other lead free.

( ) C6. Cut one lead of a 1 μfd mylar capacitor to a length of 3/4". Connect this lead to lug 6 on deck B of the range switch (S-2). Leave the other lead free.



Detail 3A

TOP CHASSIS WIRING

Refer to Pictorial 3 for the following steps.

( ) Place the top chassis on your work surface in front of you as shown in Pictorial 3.

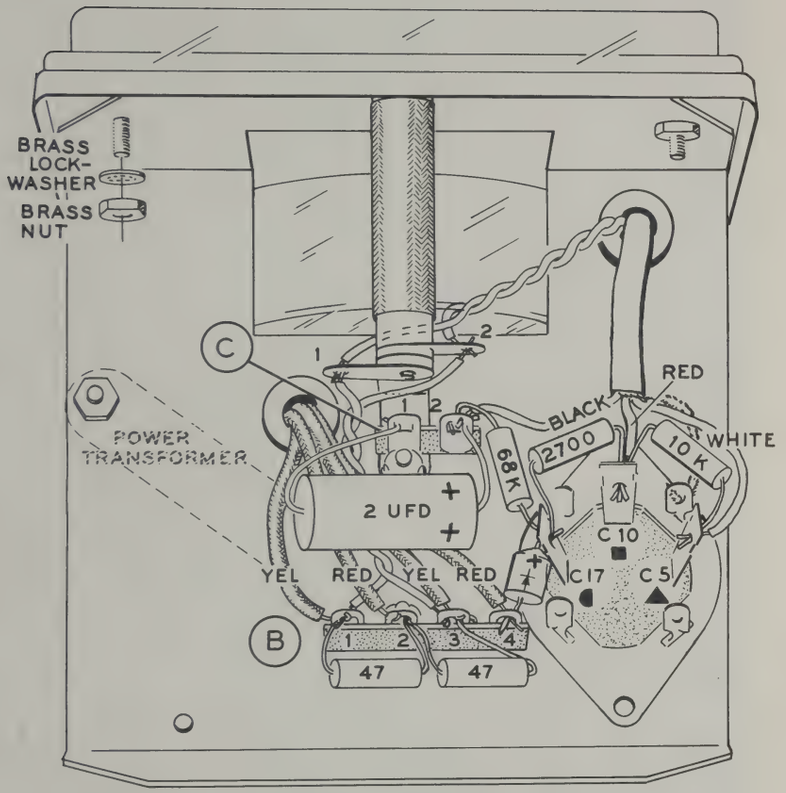
( ) Install two grommets in the positions shown.

( ) Install the #47 lamp in the pilot lamp socket and place the length of 3/8" sleeving over the lamp.

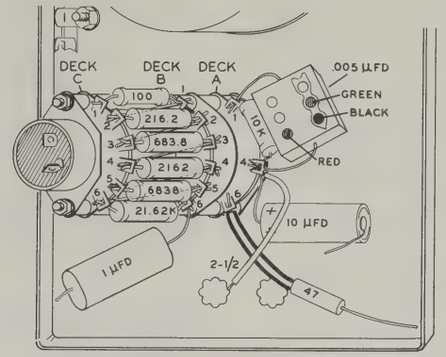
( ) Mount the pilot lamp socket along with 2-lug terminal strip C. Use a 6-32 x 1/4" screw, two #6 lockwashers (one under the nut, and one between the lamp bracket and the terminal strip mounting foot), and a 6-32 nut.

( ) Insert the yellow and red leads through the grommet and mount the power transformer as shown in Detail 3A. Use a 6-32 x 1/4" screw, #6 lockwasher, and 6-32 nut at the mounting hole near the edge of the chassis. Using a 6-32 x 3/8" screw in the other mounting hole, mount a 2-lug terminal strip on top of the chassis and a 4-lug terminal strip (#431-40) below the chassis as shown. Use three #6 lockwashers as shown and a 6-32 nut.

( ) Install the capacitor mounting wafer, using a 6-32 x 1/4" screw, #6 lockwasher, and 6-32 nut in the mounting hole near the front of the chassis. The second screw will be installed in the wafer when the top chassis is connected to the back plate.



PICTORIAL 3



PICTORIAL 2

Refer to Pictorial 2 for the following steps.

R13. Connect a 100 Ω precision resistor from lug 1 on deck B (NS) to lug 1 on deck C (NS) of the range switch.

Connect a 1-1/2" length of bare wire from lug 2 on deck C (NS) to lug 1 on deck B (S-2) of the range switch.

R12. Connect a 216.2 Ω precision resistor from lug 2 on deck C (S-2) to lug 2 on deck B (NS) of the range switch.

Connect a 1-1/2" length of bare wire from lug 2 on deck B (S-2) to lug 3 on deck C (NS) of the range switch.

R11. Connect a 683.8 Ω precision resistor from lug 3 on deck C (S-2) to lug 3 on deck B (NS) of the range switch.

Connect a 1-1/2" length of bare wire from lug 3 on deck B (S-2) to lug 4 on deck C (NS) of the range switch.

R10. Connect a 2162 Ω precision resistor from lug 4 on deck C (S-2) to lug 4 on deck B (NS) of the range switch.

Connect a 1-1/2" length of bare wire from lug 4 on deck B (S-2) to lug 5 on deck C (NS) of the range switch.

R9. Connect a 6838 Ω precision resistor from lug 5 on deck C (S-2) to lug 5 on deck B (NS) of the range switch.

Connect a 1-1/2" length of hookup wire from lug 5 on deck B (S-2) to lug 6 on deck C (NS) of the range switch.

R8. Connect a 21.62 KΩ precision resistor from lug 6 on deck C (S-2) to lug 6 on deck B (NS) of the range switch.

R2. Connect a 10 KΩ precision resistor from lug 1 (NS) to lug 4 (NS) on deck A of the range switch.

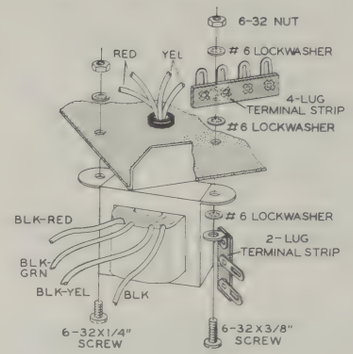
C3. Connect a .005 µfd mica capacitor from lug 1 (S-3) to lug 4 (NS) on deck A of the range switch.

Connect one end of a 2-1/2" length of hookup wire to lug 4 on deck A of the range switch (NS). Leave the other lead free.

C4. Cut the positive (+) lead of the 10 µfd electrolytic capacitor to a length of 1". Connect this lead to lug 4 on deck A of the range switch (S-4). Leave the other lead free.

R4. Place sleeving over one lead of a 47 Ω (yellow-violet-black) resistor and connect it to lug 6 on deck A of the range switch (S-1). Leave the other lead free.

C6. Cut one lead of a 1 µfd mylar capacitor to a length of 3/4". Connect this lead to lug 6 on deck B of the range switch (S-2). Leave the other lead free.



Detail 3A

TOP CHASSIS WIRING

Refer to Pictorial 3 for the following steps.

Place the top chassis on your work surface in front of you as shown in Pictorial 3.

Install two grommets in the positions shown.

Install the #47 lamp in the pilot lamp socket and place the length of 3/8" sleeving over the lamp.

Mount the pilot lamp socket along with 2-lug terminal strip C. Use a 6-32 x 1/4" screw, two #6 lockwashers (one under the nut, and one between the lamp bracket and the terminal strip mounting foot), and a 6-32 nut.

Insert the yellow and red leads through the grommet and mount the power transformer as shown in Detail 3A. Use a 6-32 x 1/4" screw, #6 lockwasher, and 6-32 nut at the mounting hole near the edge of the chassis. Using a 6-32 x 3/8" screw in the other mounting hole, mount a 2-lug terminal strip on top of the chassis and a 4-lug terminal strip (#431-40) below the chassis as shown. Use three #6 lockwashers as shown and a 6-32 nut.

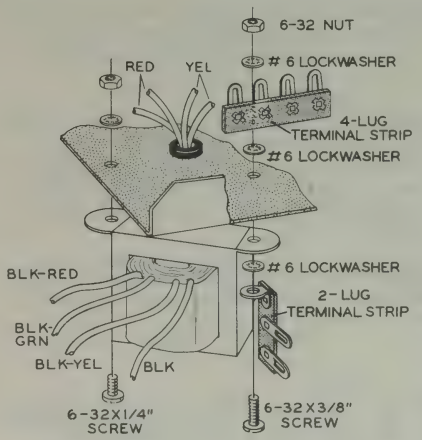
Install the capacitor mounting wafer, using a 6-32 x 1/4" screw, #6 lockwasher, and 6-32 nut in the mounting hole near the front of the chassis. The second screw will be installed in the wafer when the top chassis is connected to the back plate.

( ) Connect one end of a 2-1/2" length of hookup wire to lug 4 on deck A of the range switch (NS). Leave the other lead free.

( ) C4. Cut the positive (+) lead of the 10 μfd electrolytic capacitor to a length of 1". Connect this lead to lug 4 on deck A of the range switch (S-4). Leave the other lead free.

( ) R4. Place sleeving over one lead of a 47 Ω (yellow-violet-black) resistor and connect it to lug 6 on deck A of the range switch (S-1). Leave the other lead free.

( ) C6. Cut one lead of a 1 μfd mylar capacitor to a length of 3/4". Connect this lead to lug 6 on deck B of the range switch (S-2). Leave the other lead free.



Detail 3A

TOP CHASSIS WIRING

Refer to Pictorial 3 for the following steps.

( ) Place the top chassis on your work surface in front of you as shown in Pictorial 3.

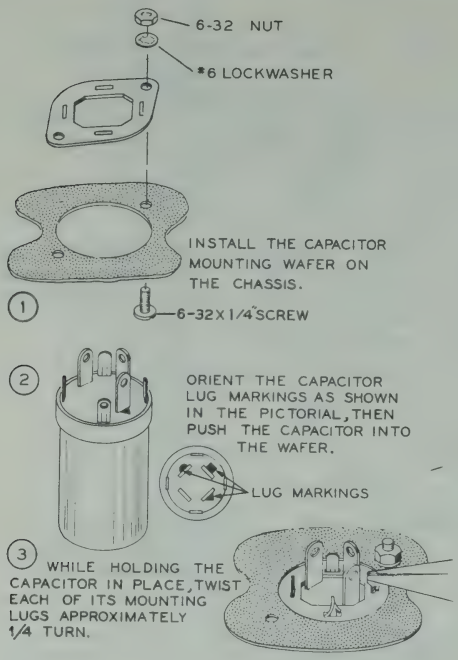
( ) Install two grommets in the positions shown.

( ) Install the #47 lamp in the pilot lamp socket and place the length of 3/8" sleeving over the lamp.

( ) Mount the pilot lamp socket along with 2-lug terminal strip C. Use a 6-32 x 1/4" screw, two #6 lockwashers (one under the nut, and one between the lamp bracket and the terminal strip mounting foot), and a 6-32 nut.

( ) Insert the yellow and red leads through the grommet and mount the power transformer as shown in Detail 3A. Use a 6-32 x 1/4" screw, #6 lockwasher, and 6-32 nut at the mounting hole near the edge of the chassis. Using a 6-32 x 3/8" screw in the other mounting hole, mount a 2-lug terminal strip on top of the chassis and a 4-lug terminal strip (#431-40) below the chassis as shown. Use three #6 lockwashers as shown and a 6-32 nut.

( ) Install the capacitor mounting wafer, using a 6-32 x 1/4" screw, #6 lockwasher, and 6-32 nut in the mounting hole near the front of the chassis. The second screw will be installed in the wafer when the top chassis is connected to the back plate.



Detail 3B

( ) C5, C10, C17. Mount the 20-40-80 µfd electrolytic capacitor on the capacitor mounting wafer as shown in Detail 3B. Be sure that the blank space in the capacitor faces as shown in Pictorial 3.

( ) Solder one of the mounting lugs of the filter capacitor to the capacitor mounting wafer. This is done to insure the best possible ground connection.

NOTE: The purpose of using twisted pairs of hookup wire is to cancel hum in the filament leads. Best results will be obtained if the wires are twisted approximately two complete turns per inch.

( ) Twist together two 3-1/2" hookup wires. At one end of these twisted wires, connect one of the wires to lug 1 (NS) and connect the other wire to lug 2 (NS) of the pilot lamp socket.

( ) At the other end of these twisted wires, connect one wire to lug 1 (NS) and connect the other wire to lug 3 (NS) of terminal strip B.

( ) Twist together two 11-1/2" hookup wires. At one end of these twisted hookup wires, connect one wire to lug 1 (S-2) and connect the other wire to lug 2 (S-2) of the pilot lamp socket. Insert the other end of this twisted pair down through the grommet as shown, it will be connected later.

NOTE: In each of the following steps, cut the indicated power transformer lead to the correct length, remove 1/4" of insulation and "tin" the end. ("Tin" means to melt a small amount of solder on the exposed lead end.)

( ) Connect one of the yellow leads to lug 1 of terminal strip B (NS).

( ) Connect one of the red leads to lug 2 of terminal strip B (NS).

( ) Connect the other yellow lead to lug 3 of terminal strip B (NS).

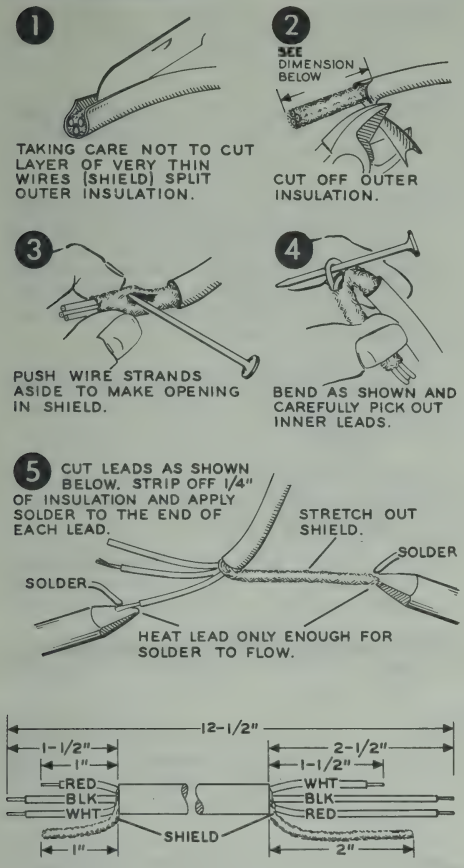
( ) Connect the other red lead to lug 4 of terminal strip B (NS).

( ) Prepare a 12-1/2" length of 3-conductor shielded cable as shown in Detail 3C.

( ) Insert the end of the cable that has the 1" shield, up through the grommet and connect the leads as follows:

( ) Connect the shield to the nearest ground lug of the filter capacitor (S-1).

( ) Connect the red wire to the lug of electrolytic capacitor C10 (NS).



Detail 3C

( ) Connect the black wire to lug 2 of terminal strip C (NS).

( ) Connect the white wire to the lug of electrolytic capacitor C5 (NS).

( ) R22. Connect a 68 KΩ (blue-gray-orange) resistor from lug 2 of terminal strip C (NS) to the lug of capacitor C17 (NS).

( ) Connect the lead from the positive (-▶|+) end of the silicon rectifier to the lug of electrolytic capacitor C17 (NS). Connect the other lead of this silicon rectifier to lug 4 of terminal strip B (S-2).

( ) R21. Connect a 2700 Ω (red-violet-red) resistor from the lug of electrolytic capacitor C17 (S-3) to the lug of electrolytic capacitor C10 (NS).

( ) R6. Connect a 10 KΩ (brown-black-orange) resistor from the lug of electrolytic capacitor C10 (S-3) to the lug of electrolytic capacitor C5 (S-2).

( ) R28. Connect a 47 Ω (yellow-violet-black) resistor from lug 1 (S-3) to lug 2 (NS) of terminal strip B.

( ) R29. Connect a 47 Ω (yellow-violet-black) resistor from lug 2 (S-3) to lug 3 (S-3) of terminal strip B.

( ) C11. Connect the positive (+) lead of a 2 μfd 150 volt electrolytic capacitor to lug 2 of terminal strip C (S-3). Connect the other lead of this capacitor to lug 1 of terminal strip C (S-1).

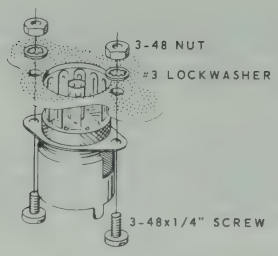
( ) Remove the two top nuts and lockwashers that hold the meter to the front panel.

( ) Fasten the top chassis in position as shown in Pictorial 3 by replacing these nuts and lockwashers, and tightening them.

WIRING THE BOTTOM CHASSIS

Refer to Pictorial 4 for the following steps.

( ) Mount 9-pin tube sockets V1 and V2 as shown in Detail 4A. Use 3-48 x 1/4" screws, #3 lockwashers, and 3-48 nuts. Be sure to align the open spaces as shown.



Detail 4A

( ) Mount 2-lug terminal strip D, using a 6-32 x 1/4" screw, #6 lockwashers, and a 6-32 nut. Install the #6 solder lug, facing as shown, under the screw on the other side of the chassis.

( ) Mount terminal strips E, F, and G, using 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts.

( ) Twist two 3" lengths of hookup wire together. At one end connect one wire to lug 4 (NS) and the other wire to lug 5 (NS) of tube socket V1.

( ) At the other end of this twisted pair of hookup wires, connect one wire to lug 4 (S-1) and connect the other wire to lug 5 (S-1) of tube socket V2.

( ) Connect a 3-1/2" length of hookup wire from lug 4 of terminal strip F (NS) to lug 2 of tube socket V2 (NS).

( ) R3. Connect a 47 KΩ (yellow-violet-orange) resistor from lug 1 (NS) to lug 2 (NS) of terminal strip D.

( ) C13. Connect the lead from the banded end of a .1 μfd tubular capacitor to lug 1 of terminal strip F (NS). Connect the other lead of this capacitor to lug 4 of terminal strip F (S-2). Make sure this capacitor does not cover the chassis hole near the flange of the chassis.

( ) Connect a length of bare wire from lug 9 of tube socket V1 (S-1) to lug 1 of terminal strip F (NS).

( ) R16. Connect a 47 KΩ (yellow-violet-orange) resistor from lug 1 (S-3) to lug 2 (NS) of terminal strip F.

( ) R14. Connect a 470 KΩ (yellow-violet-yellow) resistor from lug 2 of terminal strip F (NS) to lug 8 of tube socket V1 (NS).

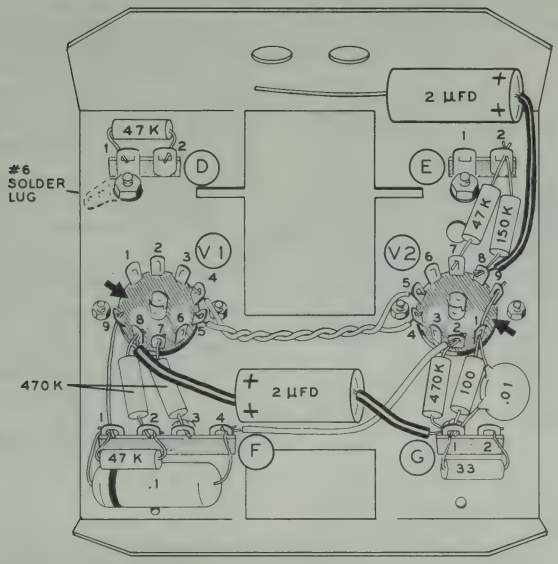
( ) R15. Connect a 470 KΩ (yellow-violet-yellow) resistor from lug 7 of tube socket V1 (NS) to lug 3 of terminal strip F (NS).

( ) C7. Cut the positive (+) lead of a 2 μfd 150 volt electrolytic capacitor to a length of 1-1/4". Place 1" of sleeving over this lead and connect it to lug 8 of tube socket V1 (S-2).

( ) Cut the negative lead of this capacitor to the proper length and connect it to lug 1 of terminal strip G (NS). Use sleeving.

( ) R24. Connect a 47 KΩ (yellow-violet-orange) resistor from lug 7 of tube socket V2 (NS) to lug 2 of terminal strip E (NS).

( ) R23. Connect a 150 KΩ (brown-green-yellow) resistor from lug 8 of tube socket V2 (NS) to lug 2 of terminal strip E (NS).



PICTORIAL 4

C12. Cut the positive (+) lead of a 2 µfd 150 volt electrolytic capacitor to a length of 1-3/4" and place 1-1/2" of sleeving over it. Connect this lead to lug 8 of tube socket V2 (S-2). Cut the other lead of this capacitor to a length of 3/4" and place the capacitor as shown in Pictorial 4. The other lead will be connected later.

R19. Connect a 33 Ω (orange-orange-black) resistor from lug 1 (NS) to lug 2 (NS) of terminal strip G.

R26. Insert one lead of a 100 Ω (brown-black-brown) resistor through lug 1 (NS) to lug 9 (S-1) of tube socket V2. Connect the other lead of this resistor to lug 1 of terminal strip G (NS).

C14. Connect a .01 µfd disc capacitor from lug 1 of tube socket V2 (S-3) to lug 1 of terminal strip G (NS).

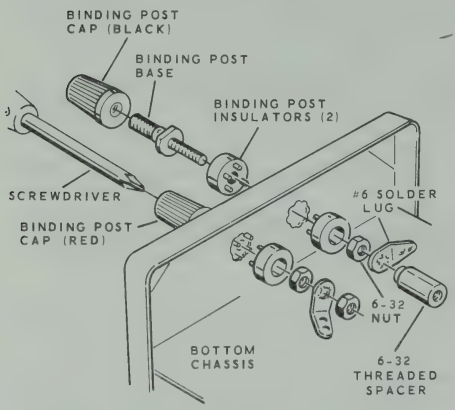
R25. Connect a 470 KΩ (yellow-violet-yellow) resistor from lug 2 of tube socket V2 (S-2) to lug 1 of terminal strip G (NS).

Refer to Pictorial 5 for the following steps.

When you fasten the bottom chassis to the front panel in the next step, be sure to direct the prewired range switch components (47Ω resistor; .02, .1, and 1 μfd capacitors; one hookup wire) up through the large opening in the bottom chassis.

( ) Fasten the bottom chassis to the front panel as shown in Detail 5A by installing the two binding posts at the bottom of the front panel. Use two 6-32 nuts on the one binding post, and one 6-32 nut with the 6-32 threaded spacer on the other binding post, as shown. Place the solder lugs as shown.

( ) Slightly spread the open end of the binding posts with a phillips screwdriver after the binding post caps have been screwed on. Tap the screwdriver lightly. This will keep the caps from falling off.



Detail 5A

NOTE: The switch shield will be inserted down through the long open slot between terminal strips D and E. Be sure that you do not wire any components across this open space since they would prevent the shield from being installed later.

( ) Connect the free lead of the 1 μfd mylar capacitor to lug 1 of tube socket V1 (NS). Place the body of the capacitor against the chassis as shown.

( ) Cut the free lead of the .1 μfd tubular capacitor coming from the range switch to a length of 1-1/2" and place 1" of sleeving over it. Connect this lead to lug 7 of tube socket V1 (S-2).

( ) Place the body of the 47 Ω resistor coming from the range switch close to terminal strip D as shown. Connect this lead to lug 2 of tube socket V1 (S-1).

( ) Connect the free lead of the .02 μfd disc capacitor coming from the range switch to solder lug 1 of the input terminals (S-1).

( ) Connect the 3/4" free lead of the 2 μfd 150 volt electrolytic capacitor to solder lug 2 of the input terminals (NS).

( ) Connect a 1" length of bare wire from solder lug 2 of the input terminals (S-2) to lug 1 of terminal strip E (NS).

( ) R7. Connect a 10 KΩ (brown-black-orange) resistor from lug 1 of tube socket V1 (S-2) to lug 1 of terminal strip D (S-2).

( ) R5. Connect a 470 KΩ (yellow-violet-yellow) resistor from lug 2 of terminal strip D (NS) to lug 3 of tube socket V1 (NS).

( ) Connect the hookup wire coming from lug 4 of deck A of the range switch to lug 2 of terminal strip D (S-3).

( ) Note the 3-conductor shielded cable and the twisted hookup wires coming from the grommet in the corner of the top chassis. Route these up behind the front panel and through the opening in the bottom chassis as shown.

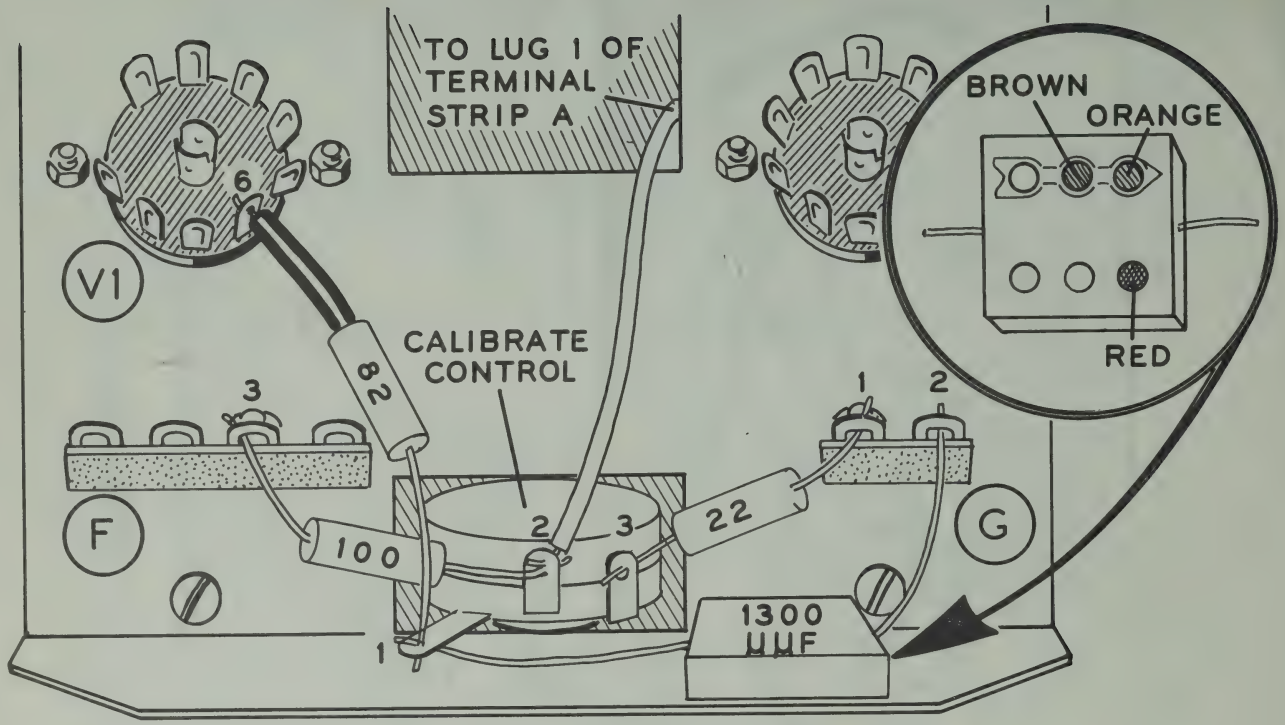
( ) At the free end of the twisted pair of hookup wires that come from the top chassis connect one wire to lug 4 (S-2) and connect the other wire to lug 5 (S-2) of tube socket V1.

( ) Connect the shield of the 3-conductor cable to lug 1 of terminal strip E (S-2).

( ) Connect the black lead of the 3-conductor shielded cable to lug 2 of terminal strip E (S-3).

( ) Connect the white lead of the 3-conductor shielded cable to lug 3 of tube socket V1 (S-2).

( ) Connect the red lead of the 3-conductor shielded cable to lug 2 of terminal strip F (S-3).


TO LUG 1 OF TERMINAL STRIP A
6
V1
82
CALIBRATE CONTROL
3
F
100
2
3
22
1
2
G
1300 UUF
1
BROWN
ORANGE
RED

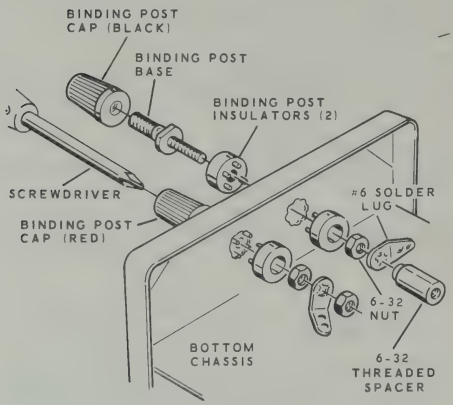
PICTORIAL 7

Refer to Pictorial 5 for the following steps.

When you fasten the bottom chassis to the front panel in the next step, be sure to direct the prewired range switch components (47Ω resistor; .02, .1, and 1 μfd capacitors; one hookup wire) up through the large opening in the bottom chassis.

( ) Fasten the bottom chassis to the front panel as shown in Detail 5A by installing the two binding posts at the bottom of the front panel. Use two 6-32 nuts on the one binding post, and one 6-32 nut with the 6-32 threaded spacer on the other binding post, as shown. Place the solder lugs as shown.

( ) Slightly spread the open end of the binding posts with a phillips screwdriver after the binding post caps have been screwed on. Tap the screwdriver lightly. This will keep the caps from falling off.



Detail 5A

NOTE: The switch shield will be inserted down through the long open slot between terminal strips D and E. Be sure that you do not wire any components across this open space since they would prevent the shield from being installed later.

( ) Connect the free lead of the 1 μfd mylar capacitor to lug 1 of tube socket V1 (NS). Place the body of the capacitor against the chassis as shown.

( ) Cut the free lead of the .1 μfd tubular capacitor coming from the range switch to a length of 1-1/2" and place 1" of sleeving over it. Connect this lead to lug 7 of tube socket V1 (S-2).

( ) Place the body of the 47 Ω resistor coming from the range switch close to terminal strip D as shown. Connect this lead to lug 2 of tube socket V1 (S-1).

( ) Connect the free lead of the .02 μfd disc capacitor coming from the range switch to solder lug 1 of the input terminals (S-1).

( ) Connect the 3/4" free lead of the 2 μfd 150 volt electrolytic capacitor to solder lug 2 of the input terminals (NS).

( ) Connect a 1" length of bare wire from solder lug 2 of the input terminals (S-2) to lug 1 of terminal strip E (NS).

( ) R7. Connect a 10 KΩ (brown-black-orange) resistor from lug 1 of tube socket V1 (S-2) to lug 1 of terminal strip D (S-2).

( ) R5. Connect a 470 KΩ (yellow-violet-yellow) resistor from lug 2 of terminal strip D (NS) to lug 3 of tube socket V1 (NS).

( ) Connect the hookup wire coming from lug 4 of deck A of the range switch to lug 2 of terminal strip D (S-3).

( ) Note the 3-conductor shielded cable and the twisted hookup wires coming from the grommet in the corner of the top chassis. Route these up behind the front panel and through the opening in the bottom chassis as shown.

( ) At the free end of the twisted pair of hookup wires that come from the top chassis connect one wire to lug 4 (S-2) and connect the other wire to lug 5 (S-2) of tube socket V1.

( ) Connect the shield of the 3-conductor cable to lug 1 of terminal strip E (S-2).

( ) Connect the black lead of the 3-conductor shielded cable to lug 2 of terminal strip E (S-3).

( ) Connect the white lead of the 3-conductor shielded cable to lug 3 of tube socket V1 (S-2).

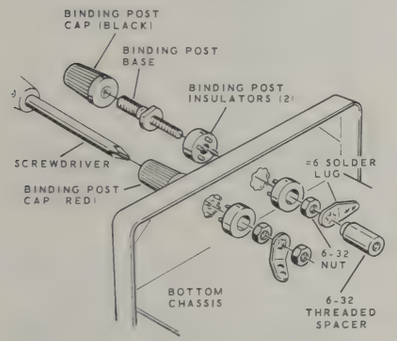
( ) Connect the red lead of the 3-conductor shielded cable to lug 2 of terminal strip F (S-3).

Refer to Pictorial 5 for the following steps.

When you fasten the bottom chassis to the front panel in the next step, be sure to direct the prewired range switch components (47Ω resistor; .02, .1, and 1 μfd capacitors; one hookup wire) up through the large opening in the bottom chassis.

( ) Fasten the bottom chassis to the front panel as shown in Detail 5A by installing the two binding posts at the bottom of the front panel. Use two 6-32 nuts on the one binding post, and one 6-32 nut with the 6-32 threaded spacer on the other binding post, as shown. Place the solder lugs as shown.

( ) Slightly spread the open end of the binding posts with a phillips screwdriver after the binding post caps have been screwed on. Tap the screwdriver lightly. This will keep the caps from falling off.



Detail 5A

NOTE: The switch shield will be inserted down through the long open slot between terminal strips D and E. Be sure that you do not wire any components across this open space since they would prevent the shield from being installed later.

( ) Connect the free lead of the 1 μfd mylar capacitor to lug 1 of tube socket V1 (NS). Place the body of the capacitor against the chassis as shown.

( ) Cut the free lead of the .1 μfd tubular capacitor coming from the range switch to a length of 1-1/2" and place 1" of sleeving over it. Connect this lead to lug 7 of tube socket V1 (S-2).

( ) Place the body of the 47 Ω resistor coming from the range switch close to terminal strip D as shown. Connect this lead to lug 2 of tube socket V1 (S-1).

( ) Connect the free lead of the .02 μfd disc capacitor coming from the range switch to solder lug 1 of the input terminals (S-1).

( ) Connect the 3/4" free lead of the 2 μfd 150 volt electrolytic capacitor to solder lug 2 of the input terminals (NS).

( ) Connect a 1" length of bare wire from solder lug 2 of the input terminals (S-2) to lug 1 of terminal strip E (NS).

( ) R7. Connect a 10 KΩ (brown-black-orange) resistor from lug 1 of tube socket V1 (S-2) to lug 1 of terminal strip D (S-2).

( ) R5. Connect a 470 KΩ (yellow-violet-yellow) resistor from lug 2 of terminal strip D (NS) to lug 3 of tube socket V1 (NS).

( ) Connect the hookup wire coming from lug 4 of deck A of the range switch to lug 2 of terminal strip D (S-3).

( ) Note the 3-conductor shielded cable and the twisted hookup wires coming from the grommet in the corner of the top chassis. Route these up behind the front panel and through the opening in the bottom chassis as shown.

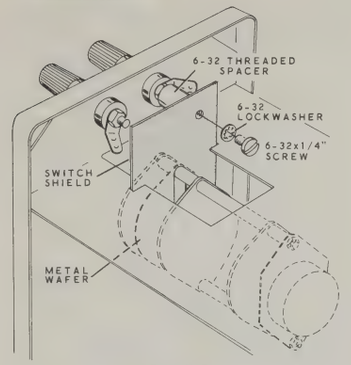
( ) At the free end of the twisted pair of hookup wires that come from the top chassis connect one wire to lug 4 (S-2) and connect the other wire to lug 5 (S-2) of tube socket V1.

( ) Connect the shield of the 3-conductor cable to lug 1 of terminal strip E (S-2).

( ) Connect the black lead of the 3-conductor shielded cable to lug 2 of terminal strip E (S-3).

( ) Connect the white lead of the 3-conductor shielded cable to lug 3 of tube socket V1 (S-2).

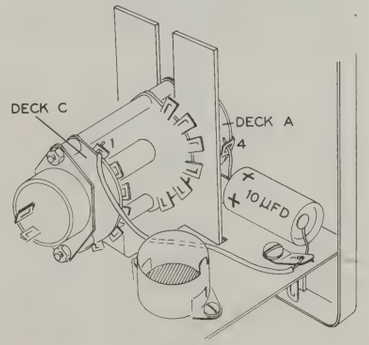
( ) Connect the red lead of the 3-conductor shielded cable to lug 2 of terminal strip F (S-3).



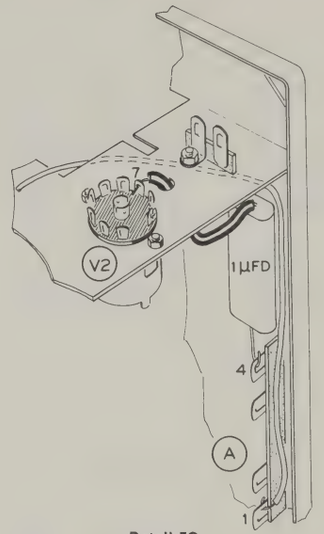
Detail 5B

( ) Install the switch shield as shown in Detail 5B. Place the slot in the switch shield over the mounting shaft of the range switch between the metal wafer and deck B. Fasten the switch shield to the threaded spacer with a 6-32 x 1/4" screw and a #6 lockwasher. Make sure that the shield does not touch any of the switch lugs or any bare wires to components.

( ) Cut one lead of a 1 μfd mylar capacitor to a length of 3/4" and connect it to lug 4 of terminal strip A (S-3). See Detail 5C.



Detail 5D



Detail 5C

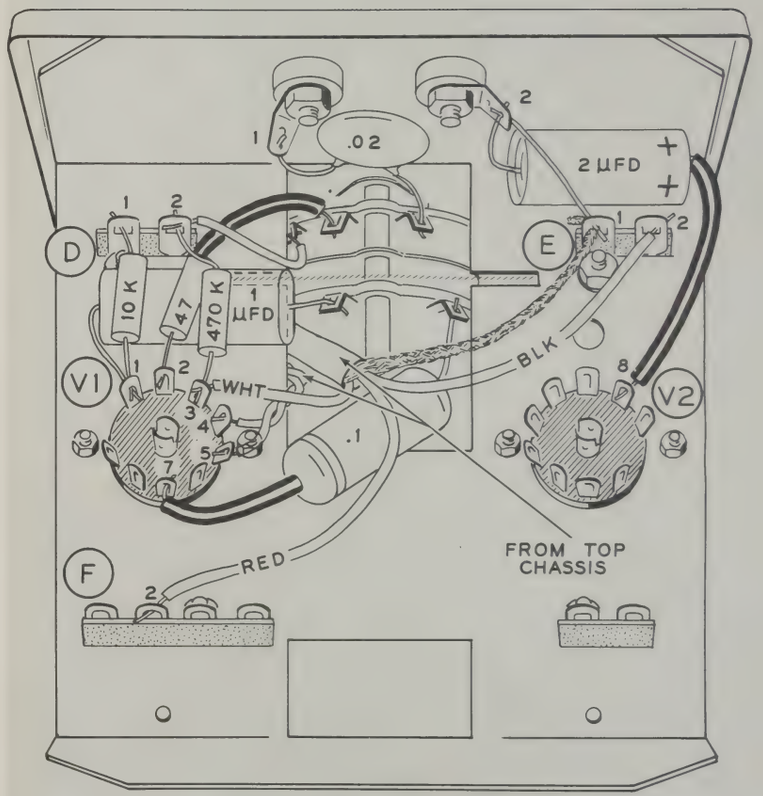
( ) Place a 1-3/4" length of sleeving over the remaining lead of this capacitor and insert it up through the hole in the chassis near lug 7 of V2. Now connect this lead to lug 7 of V2 (S-2). Be sure that capacitor is placed against the front panel.

( ) Route the 8" wire coming from lug 1 of terminal strip A up the side of the front panel and through the large hole in the bottom chassis as shown in Detail 5C.

Refer to Detail 5D for the following steps.

( ) Connect a 4-1/4" length of hookup wire from lug 1 of deck C on the range switch (S-2) to the ground lug near tube socket V1 (NS).

( ) Connect the negative lead of the 10 μfd capacitor coming from lug 4 of deck A on the range switch to the ground lug near tube socket V1 (S-2).



PICTORIAL 5

POWER TRANSFORMER WIRING

Refer to Pictorial 6 for the following steps.

NOTE: The power transformer has a dual primary winding and can be wired to operate from either 120 volts or 240 volts. Determine the AC line voltage in your area and follow the proper set of steps to wire the power transformer. Perform either the 120 Volt Wiring steps or the 240 Volt Wiring steps.

120 Volt Wiring

Black lead and black-green lead to lug 2 of terminal strip H (NS).

Black-yellow lead and black-red lead to lug 2 of the ON-OFF switch (S-2).

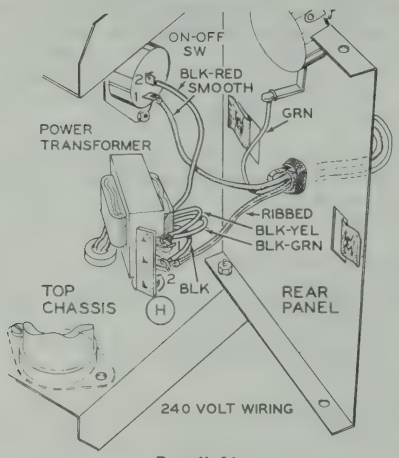
240 Volt Wiring

Refer to Detail 6A for the next three steps only.

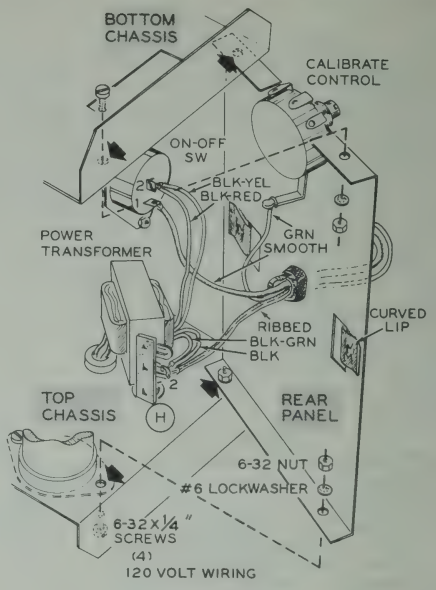
( ) Black lead to lug 2 of terminal strip H (NS).

( ) Black-yellow lead and black-green lead to lug 1 of terminal strip H (S-2).

( ) Black-red lead to lug 2 of ON-OFF switch (S-1).



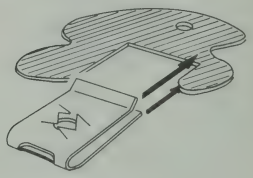
Detail 6A



PICTORIAL 6

FINAL WIRING AND ASSEMBLY

Mount the two speednuts on the back plate as shown in Detail 6B. Be sure that the correct side of the speednuts face toward you as shown in Pictorial 6.



Detail 6B

Install the 40 Ω control on the rear panel with a control solder lug, control flat washer, and control nut. Place the lugs of the control upward as they are shown, with the arm of the control solder lug opposite.

( ) Using a 6-32 x 1/4" screw, #6 lockwasher, and a 6-32 nut, fasten the corner of the rear panel loosely to the chassis as it appears in Pictorial 6.

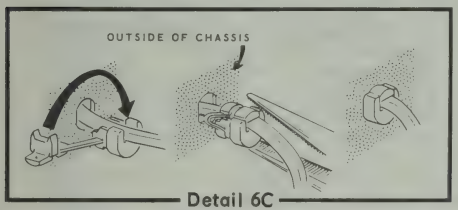
NOTE: Observe that the two edges of the line cord are different. One edge is smooth but the other edge is ribbed for identification.

( ) Separate the three wires of the line cord for a distance of 3". Remove 1/4" of insulation from the end of each wire, and then melt a small amount of solder on the end of each wire to hold the fine strands together.

( ) Insert the prepared end of the line cord through the center hole in the rear panel as shown in Pictorial 6. Connect the smooth wire to lug 1 of the ON-OFF switch (S-1), the green wire to the control solder lug at the calibrate control (S-1), and the ribbed wire to lug 2 of terminal strip H (S-3 for 120 volt wiring or S-2 for 240 volt wiring).

( ) Fasten the rear panel in position between the top chassis and the bottom chassis, using 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts. The bottom chassis will have to be raised slightly when installing the rear panel to pass the lugs of the 40 Ω control.

( ) Install the proper strain relief on the line cord where it passes through the rear panel. Detail 6C shows the strain relief (#75-71) for the flat line cord supplied with the kit. If a round line cord is used, install the other strain relief.



Detail 6C

Refer to Pictorial 7 for the following steps.

( ) R20. Connect a 22 Ω (red-red-black) resistor from lug 3 of the calibrate control (S-1) to lug 1 of terminal strip G (S-6).

( ) Bend lug 1 of the calibrate control up as it is shown in the Pictorial.

( ) Connect the free end of the wire coming from lug 1 of terminal strip A to lug 2 of the calibrate control (NS).

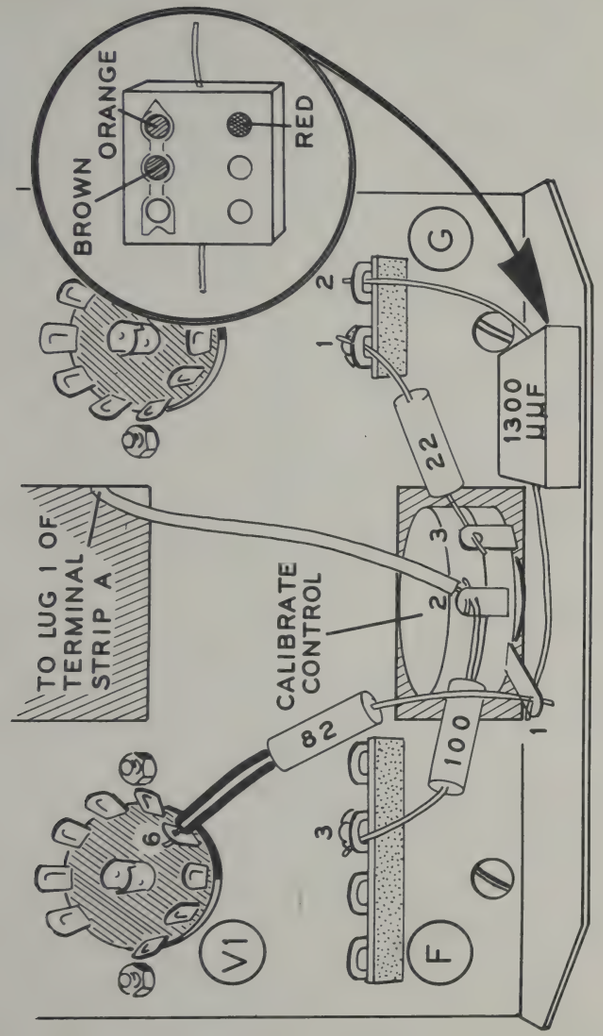
( ) R27. Connect a 100 Ω (brown-black-brown) resistor from lug 3 of terminal strip F (S-2) to lug 2 of the calibrate control (S-2).

( ) C9. Connect a 1300 μμf mica capacitor from lug 1 of the calibrate control (NS) to lug 2 of terminal strip G (S-2).

( ) R17. Connect an 82 Ω (gray-red-black) resistor from lug 6 of tube socket V1 (S-1) to lug 1 of the calibrate control (S-2). Use sleeving.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear of the cabinet (or chassis). Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

This completes the wiring. All connections should now have been soldered. Lugs 3 and 6 on socket V2 are unused.



PICTORIAL 7

POWER TRANSFORMER WIRING

Refer to Pictorial 6 for the following steps.

NOTE: The power transformer has a dual primary winding and can be wired to operate from either 120 volts or 240 volts. Determine the AC line voltage in your area and follow the proper set of steps to wire the power transformer. Perform either the 120 Volt Wiring steps or the 240 Volt Wiring steps.

120 Volt Wiring

Black lead and black-green lead to lug 2 of terminal strip H (NS).

Black-yellow lead and black-red lead to lug 2 of the ON-OFF switch (S-2).

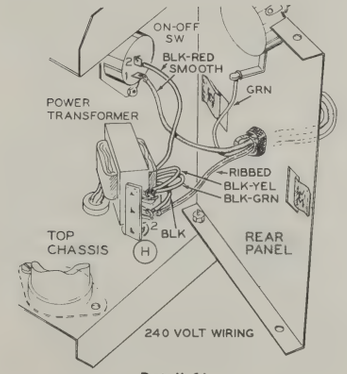
240 Volt Wiring

Refer to Detail 6A for the next three steps only.

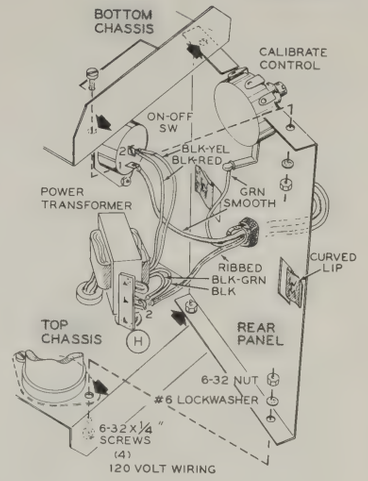
( ) Black lead to lug 2 of terminal strip H (NS).

( ) Black-yellow lead and black-green lead to lug 1 of terminal strip H (S-2).

( ) Black-red lead to lug 2 of ON-OFF switch (S-1).



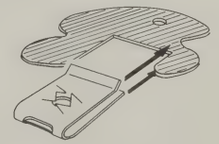
Detail 6A



PICTORIAL 6

FINAL WIRING AND ASSEMBLY

Mount the two speednuts on the back plate as shown in Detail 6B. Be sure that the correct side of the speednuts face toward you as shown in Pictorial 6.



Detail 6B

Install the 40 Ω control on the rear panel with a control solder lug, control flat washer, and control nut. Place the lugs of the control upward as they are shown, with the arm of the control solder lug opposite.

Using a 6-32 x 1/4" screw, #6 lockwasher, and a 6-32 nut, fasten the corner of the rear panel loosely to the chassis as it appears in Pictorial 6.

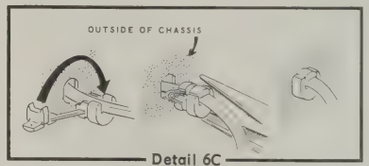
NOTE: Observe that the two edges of the line cord are different. One edge is smooth but the other edge is ribbed for identification.

Separate the three wires of the line cord for a distance of 3". Remove 1/4" of insulation from the end of each wire, and then melt a small amount of solder on the end of each wire to hold the fine strands together.

Insert the prepared end of the line cord through the center hole in the rear panel as shown in Pictorial 6. Connect the smooth wire to lug 1 of the ON-OFF switch (S-1), the green wire to the control solder lug at the calibrate control (S-1), and the ribbed wire to lug 2 of terminal strip H (S-3 for 120 volt wiring or S-2 for 240 volt wiring).

Fasten the rear panel in position between the top chassis and the bottom chassis, using 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts. The bottom chassis will have to be raised slightly when installing the rear panel to pass the lugs of the 40 Ω control.

Install the proper strain relief on the line cord where it passes through the rear panel. Detail 6C shows the strain relief (#75-71) for the flat line cord supplied with the kit. If a round line cord is used, install the other strain relief.



Detail 6C

Refer to Pictorial 7 for the following steps.

R20. Connect a 22 Ω (red-red-black) resistor from lug 3 of the calibrate control (S-1) to lug 1 of terminal strip G (S-6).

Bend lug 1 of the calibrate control up as it is shown in the Pictorial.

Connect the free end of the wire coming from lug 1 of terminal strip A to lug 2 of the calibrate control (NS).

R27. Connect a 100 Ω (brown-black-brown) resistor from lug 3 of terminal strip F (S-2) to lug 2 of the calibrate control (S-2).

C9. Connect a 1300 µµf mica capacitor from lug 1 of the calibrate control (NS) to lug 2 of terminal strip G (S-2).

R17. Connect an 82 Ω (gray-red-black) resistor from lug 6 of tube socket V1 (S-1) to lug 1 of the calibrate control (S-2). Use sleeving.

Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear of the cabinet (or chassis). Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

This completes the wiring. All connections should now have been soldered. Lugs 3 and 6 on socket V2 are unused.

( ) Using a 6-32 x 1/4" screw, #6 lockwasher, and a 6-32 nut, fasten the corner of the rear panel loosely to the chassis as it appears in Pictorial 6.

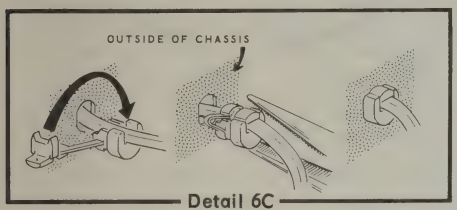
NOTE: Observe that the two edges of the line cord are different. One edge is smooth but the other edge is ribbed for identification.

( ) Separate the three wires of the line cord for a distance of 3". Remove 1/4" of insulation from the end of each wire, and then melt a small amount of solder on the end of each wire to hold the fine strands together.

( ) Insert the prepared end of the line cord through the center hole in the rear panel as shown in Pictorial 6. Connect the smooth wire to lug 1 of the ON-OFF switch (S-1), the green wire to the control solder lug at the calibrate control (S-1), and the ribbed wire to lug 2 of terminal strip H (S-3 for 120 volt wiring or S-2 for 240 volt wiring).

( ) Fasten the rear panel in position between the top chassis and the bottom chassis, using 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts. The bottom chassis will have to be raised slightly when installing the rear panel to pass the lugs of the 40 Ω control.

( ) Install the proper strain relief on the line cord where it passes through the rear panel. Detail 6C shows the strain relief (#75-71) for the flat line cord supplied with the kit. If a round line cord is used, install the other strain relief.



Detail 6C

Refer to Pictorial 7 for the following steps.

( ) R20. Connect a 22 Ω (red-red-black) resistor from lug 3 of the calibrate control (S-1) to lug 1 of terminal strip G (S-6).

( ) Bend lug 1 of the calibrate control up as it is shown in the Pictorial.

( ) Connect the free end of the wire coming from lug 1 of terminal strip A to lug 2 of the calibrate control (NS).

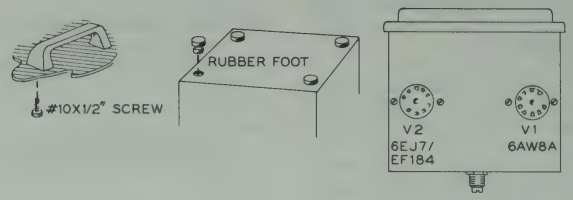
( ) R27. Connect a 100 Ω (brown-black-brown) resistor from lug 3 of terminal strip F (S-2) to lug 2 of the calibrate control (S-2).

( ) C9. Connect a 1300 μμf mica capacitor from lug 1 of the calibrate control (NS) to lug 2 of terminal strip G (S-2).

( ) R17. Connect an 82 Ω (gray-red-black) resistor from lug 6 of tube socket V1 (S-1) to lug 1 of the calibrate control (S-2). Use sleeving.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the rear of the cabinet (or chassis). Be sure to refer to the numbers on this label in any communications you have with the Heath Company about this kit.

This completes the wiring. All connections should now have been soldered. Lugs 3 and 6 on socket V2 are unused.



PICTORIAL 8

Refer to Pictorial 8 for the following steps.

( ) Install the handle at the top of the cabinet, using the two #10 x 1/2" handle screws.

( ) Install the four rubber feet in the four holes on the bottom of the cabinet.

( ) Install the tubes in their sockets; V1-6AW8, V2-6EJ7/EF184. Install a tube shield on each tube socket.

( ) Strip both ends of the lengths of black and red test lead. Prepare each of the test leads as shown in Figure 1.

( ) Fasten an alligator clip at one end of the red test lead. Install the red banana plug sleeve over the other end with the threaded end of the sleeve facing outward.

( ) Fasten the banana plug on the end of the test lead, and screw the banana plug sleeve onto the banana plug.

( ) Prepare the black test lead in the same manner.

Your VTVM is now ready for calibration.

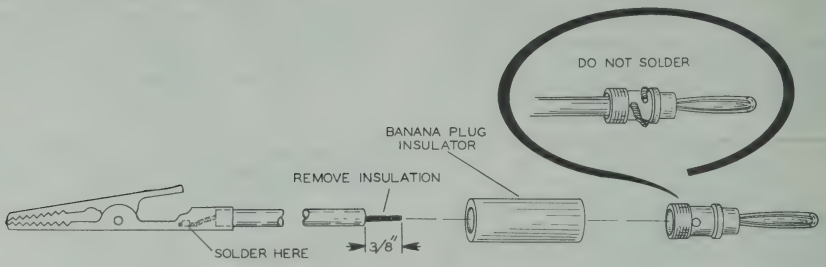


Figure 1

ADJUSTMENTS

For maximum accuracy, use an accurate AC voltmeter, and/or an accurate AC voltage source to calibrate your VTVM. If these are not available, you can make an approximate calibration by using your power line voltage as a calibrating source.

LINE VOLTAGE CALIBRATION

( ) Before turning the VTVM on, adjust the meter needle to be exactly over zero on the front panel by turning the small screw near the bottom center section of the meter face.

( ) Turn on your VTVM by turning the range switch to the 300 volt range. Allow it to operate for fifteen minutes for a thorough warmup period. If the filaments do not light or if any indication of malfunction appears, turn the unit off immediately and refer to the In Case Of Difficulty section, Page 26.

IMPORTANT: Before proceeding, read the Warning under Power Line Measurements on Page 25.

( ) Insert the banana plug on the red test lead into the red binding post.

( ) Connect the alligator clip on the red test lead to one side of the power line. If you make this connection through a wall outlet, attach the alligator clip to the shank of a screwdriver, and insert the screwdriver blade into one of the wall outlet openings. BE CAREFUL - power line voltages are dangerous. Grasp the screwdriver only by its handle. If there is no meter indication, connect to the other side of the power line.

( ) Adjust the Calibrate control so the meter needle indicates the power line voltage.

( ) Turn the trimmer capacitor (on the Range switch) to the position shown in Figure 2. This compensates the input voltage divider approximately for frequencies throughout the range of the VTVM.

Figure 2

INSTRUMENT CALIBRATION

Use an AC voltmeter of known accuracy, and an audio signal generator.

( ) Turn the VTVM on by turning the Range switch to the 3 volt range. Allow the unit to warm up for fifteen minutes. If the filaments do not light or if any indication of malfunction appears, turn the unit off immediately and refer to the In Case Of Difficulty section.

( ) Place the VTVM in its cabinet, but do not secure in place.

( ) Set the frequency of the signal generator to 1000 cps. Set the output of the signal generator to 3 volts, as measured with the standard meter.

( ) Now connect the test leads of the IM-38 VTVM to the output of the signal generator.

( ) Adjust the Calibrate control so that the meter indicates 3 volts.

( ) Remove the cabinet from the VTVM.

( ) Turn the Range switch to the 10 volt range and adjust the trimmer capacitor (on the Range switch) so that the meter indicates exactly 3 volts.

This completes the adjustment.

( ) Install the VTVM in the cabinet, using two 6-32 x 1/2" screws as shown in Figure 3.

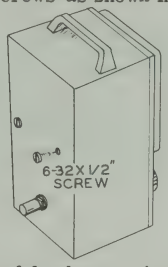


Figure 3

NOTE: Be very careful, when you install or remove the plastic control guard, that you do not change the setting of the Calibrate control.

( ) Install the plastic control guard on the Calibrate control.

OPERATION

The OFF position of the Range switch is just above the highest voltage range. This protects the instrument by insuring that it is always turned to the highest voltage range when first turned on. On the lower ranges, the meter may indicate some voltage when no connections are made to the input terminals. This residual voltage is caused by the extreme sensitivity of the instrument. Reverse the AC line plug to determine which way gives the lowest residual voltage.

The Range switch positions cover the 300, 100, 30, 10, 3, 1, .3, .1, .03, and .01 volt ranges. The meter scale is marked 0-3 and 0-10 for voltage measurements. Be sure to place the decimal in the proper place in order to indicate the correct voltage for each range.

Example 1: Using the .03 range, the meter reads 2. Move the decimal point two places to the left for the correct voltage; in this case .02 volt.

Example 2: The meter reads 6.4 on the .1 volt range. Move the decimal point two places to the left for the correct voltage; in this case .064 volt.

The decibel (db) scales range from -40 db to +50 db. When reading the db scale, add the meter reading to the range indication.

Example 1: The meter indicates -5 db and the range switch is on the +20 db range; the actual value is +15 db.

Example 2: The meter indicates -4 db and the range switch is turned to the -10 db position; the actual value is -14 db.

Do not touch the input terminals when the range switch is set to one of the low ranges. Stray electric fields picked up by the human body will deflect the pointer beyond full scale, causing the meter pointer to bang against the limit pin. Repeated extreme overloads could bend the pointer.

Although the pointer can be bent by repeated extreme overloads, the electronic circuit limits the signal applied to the meter to a safe value, thus protecting the coil windings of the meter from being damaged. NOTE: Occasionally, switching transients will cause the meter to deflect to full scale when switching from one range to another. These transients are normal, and will not harm the meter.

CAUTION: The circuit ground and the case of this instrument are both connected to the power line ground through the green line cord wire. Excepting power line measurements, always connect the Ground test lead of this VTVM to the chassis, or circuit ground, of the device being tested or measured.

APPLICATIONS

Almost any type of AC voltage, filament voltage, power line voltage, noise voltage, or even output or gain measurements can be made quickly and accurately with your AC VTVM. It is calibrated to read the root-mean-square (rms) value of a pure sine wave. This is 70.7% of the peak voltage.

POWER LINE MEASUREMENTS

WARNING: When your power line outlet is the 3-wire, polarized type, DO NOT use the common (negative) lead of the VTVM to measure power line voltages. To do so may short circuit the power line through the common lead, the chassis, and the green line cord wire.

1. Set the Range switch to 300 V.
2. Remove the meter Ground lead, if it has been inserted into the black binding post, as it will not be used for power line measurements.
3. Touch the red test lead to one side of the power line. If there is no indication on the meter, you have selected the common side of the AC line. Touch the probe to the other side of the line and you will obtain an indication.
4. To obtain contact to a wall outlet, insert a screwdriver blade into one of the outlet openings and touch the probe to the exposed part of the screwdriver blade. Try both outlet openings. BE CAREFUL.
5. If you have occasion to measure a 240 volt outlet, such as for an electric range or dryer, you will get voltage readings with the probe at two of the three openings. Add these readings together.

COMPLEX WAVEFORMS

As in most rectifier-type AC VTVMs, meter deflection is proportional to the average value of the input waveform. When measuring odd-shaped waveforms (square waves, sawtooth waves or pulses) the meter reading must be given special interpretation. Special reading material on this subject will be found listed in the Bibliography.

READING DB

Since a power level in a circuit with a fixed impedance varies with the square of the voltage, the voltage reading is indicative of the power level. Therefore, a voltmeter can be calibrated with a db scale, which provides a convenient method of measuring power loss or gain.

Basically, the db is defined as follows:

$$db = 10 \log \frac{P_1}{P_2} = \log \frac{\left(\frac{E_1}{R}\right)^2}{\left(\frac{E_2}{R}\right)^2} = 10 \log \frac{\left(E_1\right)^2}{\left(E_2\right)^2} = 20 \log \frac{\left(E_1\right)}{\left(E_2\right)}$$

Being logarithmic, it parallels to some extent the human impression of light and sound intensitities. Thus a change in signal level of a number of db will give the same impression regardless of the nominal operating level, although the change in power may be milliwatts (for low level signals) or tens of watt (for high level signals).

Since the decibel only indicates a ratio between two power levels, it is not normally referenced to any definite level. The term dbm, decibels related to 1 milliwatt, came into use so that decibels could indicate a definite level as well as a ratio. This VTVM is calibrated to read directly in dbm when connected across a 600 Ω load. (0 dbm equals 1 milliwatt into a 600 Ω load.)

CIRCUIT IMPEDANCES

Circuit impedances should be considered when comparing one db level to another. An example of this could be where the gain of an amplifier is being measured. If the input impedance is the same as the output impedance, the db gain can be measured directly with the VTVM. If the input and output impedances are different, it is necessary to adjust each reading mathematically to a common reference level.

VU APPLICATIONS

Because of the VU-type ballistics (rapid action) of the meter movement, the VTVM can be used to indicate changing AC voltages such as those that occur in speech or music. This enables you to use the VTVM to monitor audio signals, such as the input to a tape recorder in order to insure proper recording level.

BIBLIOGRAPHY

Langford-Smith, RADIOTRON DESIGNERS HANDBOOK, 4th Edition, Chapter 19, Published by RCA.

Rider, J. F., VACUUM TUBE VOLTMETER, 2nd Edition.

Turner, BASIC ELECTRONIC TEST INSTRUMENTS, Rinehart, 1953.

HEWLETT-PACKARD Journal, ARTICLES ON WAVEFORM, April-May-June 1955, Vol. 6, Numbers 8, 9, and 10.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of this manual.

3. Check to be sure that both tubes are in their proper locations. Make sure that they light up properly.

4. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.

5. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

6. Check the tubes with a tube tester or by substitution of tubes of the same types which are known to be good.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with an 11 megohm input vacuum tube voltmeter. Voltages may vary as much as 10% due to line voltage variations. Larger variations may lead you to the cause of the trouble.

8. A review of the Circuit Description will prove helpful in indicating where to look for the cause of the trouble.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the Service and Warranty sections of the "Kit Builders Guide", and to the "Factory Repair Service" information on fold-out from Page 28 of this Manual.

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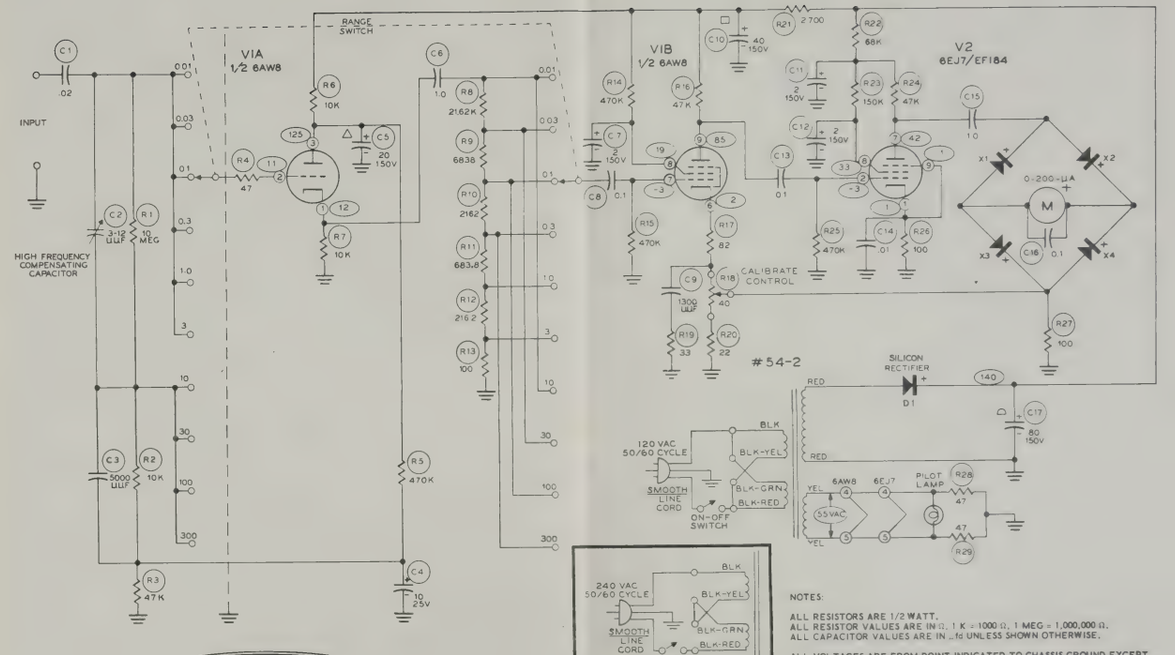
REPLACEMENT PARTS PRICE LIST

To order parts, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to Replacement Parts in the Kit Builders Guide.

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1-49	.10	22 Ω 1/2 watt
1-103	.10	33 Ω 1/2 watt
1-1	.10	47 Ω 1/2 watt
1-118	.10	82 Ω 1/2 watt
1-3	.10	100 Ω 1/2 watt
1-13	.10	2700 Ω 1/2 watt
1-20	.10	10 KΩ 1/2 watt
1-25	.10	47 KΩ 1/2 watt
1-60	.10	68 KΩ 1/2 watt
1-27	.10	150 KΩ 1/2 watt
1-33	.10	470 KΩ 1/2 watt
2-159	.20	100 Ω precision
2-25	.20	216.2 Ω precision
2-28	.20	683.8 Ω precision
2-31	.20	2162 Ω precision
2-33	.25	6838 Ω precision
2-39	.20	21.62 KΩ precision
2-17	.50	10 megohm precision
2-50	.20	10 KΩ precision
CAPACITORS		
20-71	.35	.0013 μfd mica (1300 μμf)
20-75	.80	.005 μfd mica (5000 μμf)
21-47	.10	.01 μfd disc ceramic
21-31	.10	.02 μfd disc ceramic
23-28	.20	.1 μfd tubular
27-19	1.65	1 μfd Mylar
25-39	.50	2 μfd 150 volt electrolytic
25-95	.55	10 μfd electrolytic, 25 volts
25-23	1.20	20-40-80 μfd electrolytic, 150 volts
31-13	.90	3-12 μμf trimmer
CONTROL-SWITCH-TRANSFORMER		
11-16	1.15	40 Ω control
63-502	4.15	Range switch, 11-position
54-2-24	3.10	Power transformer

PART No.	PRICE Each	DESCRIPTION
BINDING POSTS-TERMINALS		
70-5	.10	Banana plug sleeve, black
70-6	.10	Banana plug sleeve, red
75-17	.10	Binding post insulator
100-16-2	.10	Binding post cap, black
100-16-18	.10	Binding post cap, red
427-3	.15	Binding post base
431-5	.10	4-lug terminal strip
431-12	.10	4-lug terminal strip
431-14	.10	2-lug terminal strip
431-16	.10	2-lug terminal strip
431-40	.10	4-lug terminal strip
431-51	.10	1-lug terminal strip
438-13	.15	Banana plug
HARDWARE		
250-56	.05	6-32 x 1/4" screw
250-48	.05	6-32 x 1/2" screw
250-49	.05	3-48 x 1/4" screw
250-83	.05	#10 x 1/2" handle screw
250-89	.05	6-32 x 3/8" screw
252-1	.05	3-48 nut
252-3	.05	6-32 nut
252-7	.05	Control nut
440-11	.10	Plastic control guard
252-22	.05	6-32 speednut
253-10	.05	Flat control washer
254-1	.05	#6 lockwasher
254-4	.05	Control lockwasher
254-7	.05	#3 lockwasher
255-17	.10	6-32 tapped spacer
259-1	.05	#6 solder lug
259-10	.05	Control solder lug
260-1	.10	Alligator clip
WIRE-SLEEVING		
89-23	.75	Line cord
340-8	.05/ft	Bare wire
341-1	.05/ft	Black test lead
341-2	.05/ft	Red test lead
344-59	.05/ft	Hookup wire
346-1	.05/ft	Sleeving
346-6	.05/ft	3/8" sleeving
347-9	.10/ft	3-conductor shielded cable



HEATHKIT

AC VACUUM TUBE VOLTMETER
MODEL IM-38

NOTES:

ALL RESISTORS ARE 1/2 WATT.
ALL RESISTOR VALUES ARE IN Ω, 1 K = 1000 Ω, 1 MEG = 1,000,000 Ω.
ALL CAPACITOR VALUES ARE IN μfd UNLESS SHOWN OTHERWISE.

ALL VOLTAGES ARE FROM POINT INDICATED TO CHASSIS GROUND EXCEPT AC VOLTAGES ON POWER TRANSFORMER WINDINGS. READINGS WERE TAKEN WITH AN 11 MEGOHM INPUT VTVM.

VOLTAGES WERE TAKEN WITH INPUT TERMINALS SHORTED AND RANGE SWITCH IN 300 V POSITION.

PART No.	PRICE Each	DESCRIPTION
TUBES-LAMP-SOCKETS		
411-96	1.80	6AW8 tube
411-160	1.80	6EJ7/EF184 tube
412-1	.15	#47 lamp
434-43	.20	9-pin tube socket
434-44	.15	Pilot lamp socket
SHEET METAL PARTS		
200-309	.50	Top chassis
200-310	.65	Bottom chassis
203-105-3	.90	Front panel
205-603	.45	Back plate
206-179	.15	Switch shield
90-413	3.50	Cabinet
MISCELLANEOUS		
56-26	.25	Crystal diode
57-27	.50	Silicon rectifier
73-1	.10	Rubber grommet
206-54	.30	9-pin tube shield
211-15	.20	Handle
75-71	.10	Strain relief, flat cord
75-30	.10	Strain relief, round cord

PART No.	PRICE Each	DESCRIPTION
Miscellaneous (cont'd.)		
432-27	.40	Line cord adapter
455-50	.10	Knob bushing
490-5	.10	Nut starter
261-4	.05	Rubber foot
407-85	11.40	Meter
462-245	.25	Knob
481-1	.10	Capacitor mounting wafer
331-6	.15	Solder
	2.00	Manual (See front cover for part number.)

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and observe the following shipping instructions:

Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

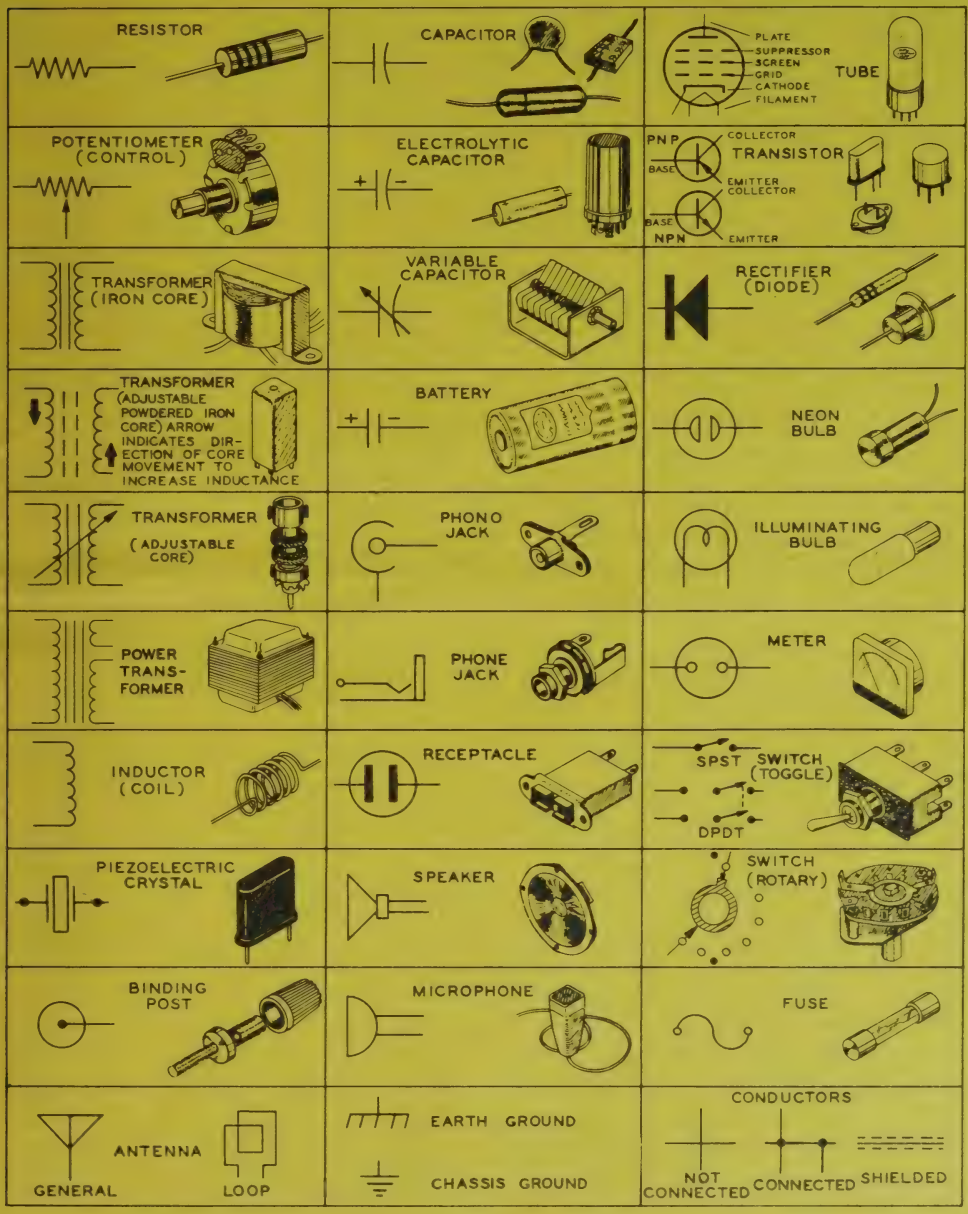
Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan 49022.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



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434-44	.15	Pilot lamp socket
SHEET METAL PARTS		
200-309	.50	Top chassis
200-310	.65	Bottom chassis
203-105-3	.90	Front panel
205-603	.45	Back plate
206-179	.15	Switch shield
90-413	3.50	Cabinet
MISCELLANEOUS		
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- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

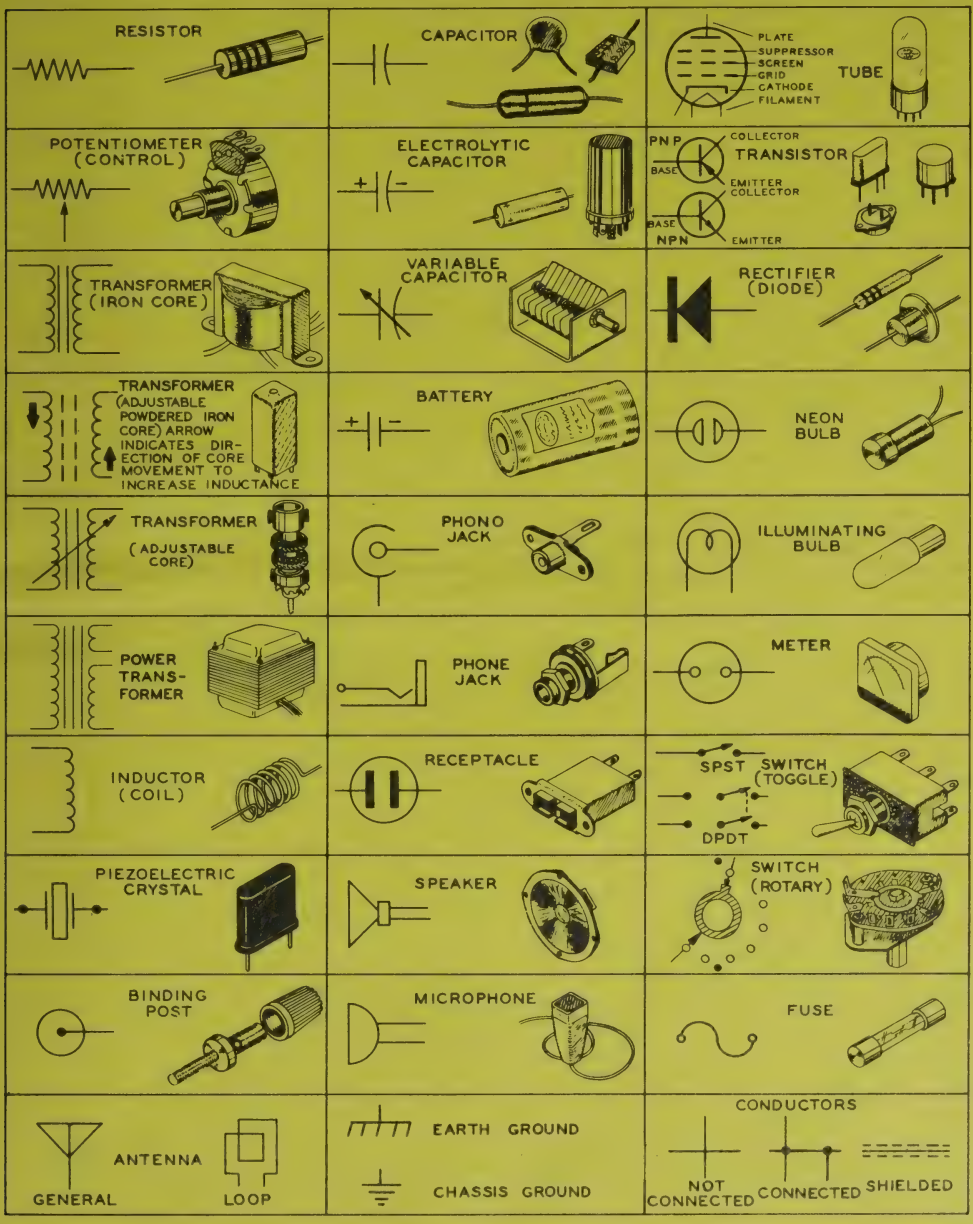
Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan 49022.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



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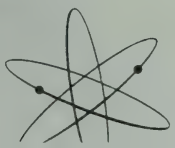


VACUUM TUBE VOLTMETER

MODEL IM-38

Assembly
and
Operation
of the

HEATHKIT

VACUUM TUBE VOLTMETER

MODEL IM-38

TABLE OF CONTENTS

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

CIRCUIT DESCRIPTION

It may be helpful to refer to the Schematic Diagram while reading the following description.

The circuit of this VTVM may be divided into four general sections: The input section, which consists of the input cathode follower and the input attenuators; the amplifier section; the meter circuit; and the power supply.

The input AC voltage is first applied to the frequency-compensated, 1000-to-1 voltage divider in the grid circuit of input cathode follower V1A. Input voltages for the lower six ranges are coupled directly to the grid of V1A from the top of the voltage divider. Input signals for the higher four ranges are divided by 1000 and coupled to the grid of V1A from the lower tap of the voltage divider.

The cathode follower stage, V1A, represents a high impedance to the input signal applied to its grid. The output of V1A is a low impedance source for the signal applied to the precision voltage divider which feeds the input of the amplifier section.

The precision voltage divider divides the signal from the cathode follower into the six different levels to provide ten scales, with readings from 10 millivolts to 300 volts.

The amplifier section consists of V1B, V2, and the various circuit components in these two stages. Approximately 19 db of negative feedback is returned through the meter circuit from V2 to the cathode circuit of V1B. This negative feedback provides high stability and uniform gain over the wide frequency range of the amplifier.

The meter circuit consists of a 200 microampere meter, with a full-wave bridge rectifier that uses four germanium diodes. For calibration purposes, the amount of meter current can be adjusted by means of the calibrate control. This control determines the amount of meter current by adjusting the amount of negative feedback to the cathode of V1B.

The power supply consists of a half-wave silicon rectifier circuit, and capacitor C17. The power supply also supplies filament voltage to the tubes and pilot lamp. In order to minimize hum, the filament winding of the power transformer is balanced to ground through resistors R28 and R29.

CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacement section and supply the information called for therein.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

ADJUSTMENTS

For maximum accuracy, use an accurate AC voltmeter, and/or an accurate AC voltage source to calibrate your VTVM. If these are not available, you can make an approximate calibration by using your power line voltage as a calibrating source.

LINE VOLTAGE CALIBRATION

( ) Before turning the VTVM on, adjust the meter needle to be exactly over zero on the front panel by turning the small screw near the bottom center section of the meter face.

( ) Turn on your VTVM by turning the range switch to the 300 volt range. Allow it to operate for fifteen minutes for a thorough warmup period. If the filaments do not light or if any indication of malfunction appears, turn the unit off immediately and refer to the In Case Of Difficulty section, Page 26.

IMPORTANT: Before proceeding, read the Warning under Power Line Measurements on Page 25.

( ) Insert the banana plug on the red test lead into the red binding post.

( ) Connect the alligator clip on the red test lead to one side of the power line. If you make this connection through a wall outlet, attach the alligator clip to the shank of a screwdriver, and insert the screwdriver blade into one of the wall outlet openings. BE CAREFUL - power line voltages are dangerous. Grasp the screwdriver only by its handle. If there is no meter indication, connect to the other side of the power line.

( ) Adjust the Calibrate control so the meter needle indicates the power line voltage.

( ) Turn the trimmer capacitor (on the Range switch) to the position shown in Figure 2. This compensates the input voltage divider approximately for frequencies throughout the range of the VTVM.

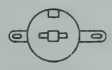


Figure 2

INSTRUMENT CALIBRATION

Use an AC voltmeter of known accuracy, and an audio signal generator.

( ) Turn the VTVM on by turning the Range switch to the 3 volt range. Allow the unit to warm up for fifteen minutes. If the filaments do not light or if any indication of malfunction appears, turn the unit off immediately and refer to the In Case Of Difficulty section.

( ) Place the VTVM in its cabinet, but do not secure in place.

( ) Set the frequency of the signal generator to 1000 cps. Set the output of the signal generator to 3 volts, as measured with the standard meter.

( ) Now connect the test leads of the IM-38 VTVM to the output of the signal generator.

( ) Adjust the Calibrate control so that the meter indicates 3 volts.

( ) Remove the cabinet from the VTVM.

( ) Turn the Range switch to the 10 volt range and adjust the trimmer capacitor (on the Range switch) so that the meter indicates exactly 3 volts.

This completes the adjustment.

( ) Install the VTVM in the cabinet, using two 6-32 x 1/2" screws as shown in Figure 3.

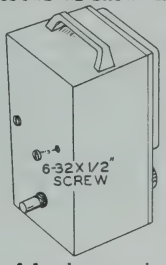


Figure 3

NOTE: Be very careful, when you install or remove the plastic control guard, that you do not change the setting of the Calibrate control.

( ) Install the plastic control guard on the Calibrate control.

APPLICATIONS

Almost any type of AC voltage, filament voltage, power line voltage, noise voltage, or even output or gain measurements can be made quickly and accurately with your AC VTVM. It is calibrated to read the root-mean-square (rms) value of a pure sine wave. This is 70.7% of the peak voltage.

POWER LINE MEASUREMENTS

WARNING: When your power line outlet is the 3-wire, polarized type, DO NOT use the common (negative) lead of the VTVM to measure power line voltages. To do so may short circuit the power line through the common lead, the chassis, and the green line cord wire.

1. Set the Range switch to 300 V.
2. Remove the meter Ground lead, if it has been inserted into the black binding post, as it will not be used for power line measurements.
3. Touch the red test lead to one side of the power line. If there is no indication on the meter, you have selected the common side of the AC line. Touch the probe to the other side of the line and you will obtain an indication.
4. To obtain contact to a wall outlet, insert a screwdriver blade into one of the outlet openings and touch the probe to the exposed part of the screwdriver blade. Try both outlet openings. BE CAREFUL.
5. If you have occasion to measure a 240 volt outlet, such as for an electric range or dryer, you will get voltage readings with the probe at two of the three openings. Add these readings together.

COMPLEX WAVEFORMS

As in most rectifier-type AC VTVMs, meter deflection is proportional to the average value of the input waveform. When measuring odd-shaped waveforms (square waves, sawtooth waves or pulses) the meter reading must be given special interpretation. Special reading material on this subject will be found listed in the Bibliography.

READING DB

Since a power level in a circuit with a fixed impedance varies with the square of the voltage, the voltage reading is indicative of the power level. Therefore, a voltmeter can be calibrated with a db scale, which provides a convenient method of measuring power loss or gain.

Basically, the db is defined as follows:

$$db = 10 \log \frac{P_1}{P_2} = \log \frac{\left(\frac{E_1}{R}\right)^2}{\left(\frac{E_2}{R}\right)^2} = 10 \log \frac{(E_1)^2}{(E_2)^2} = 20 \log \frac{(E_1)}{(E_2)}$$

Being logarithmic, it parallels to some extent the human impression of light and sound intensitities. Thus a change in signal level of a number of db will give the same impression regardless of the nominal operating level, although the change in power may be milliwatts (for low level signals) or tens of watt (for high level signals).

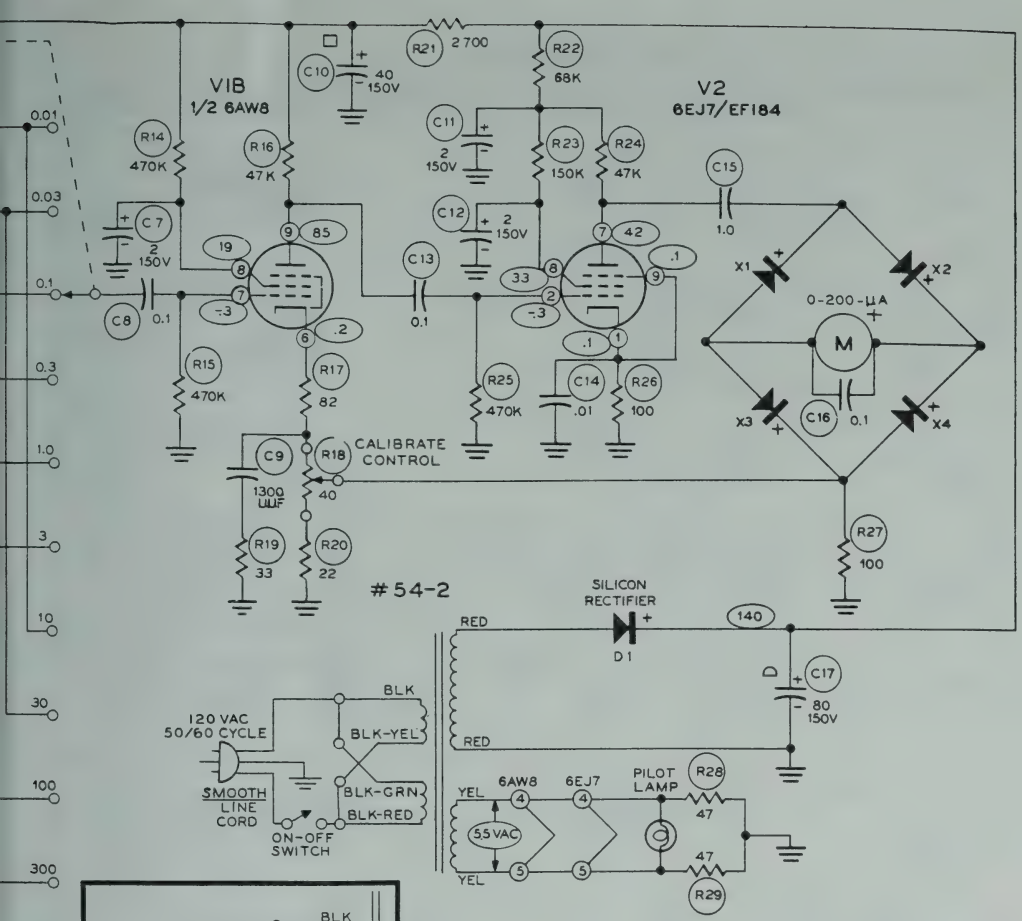
Since the decibel only indicates a ratio between two power levels, it is not normally referenced to any definite level. The term dbm, decibels related to 1 milliwatt, came into use so that decibels could indicate a definite level as well as a ratio. This VTVM is calibrated to read directly in dbm when connected across a 600 Ω load. (0 dbm equals 1 milliwatt into a 600 Ω load.)

REPLACEMENT PARTS PRICE LIST

To order parts, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to Replacement Parts in the Kit Builders Guide.

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1-49	.10	22 Ω 1/2 watt
1-103	.10	33 Ω 1/2 watt
1-1	.10	47 Ω 1/2 watt
1-118	.10	82 Ω 1/2 watt
1-3	.10	100 Ω 1/2 watt
1-13	.10	2700 Ω 1/2 watt
1-20	.10	10 KΩ 1/2 watt
1-25	.10	47 KΩ 1/2 watt
1-60	.10	68 KΩ 1/2 watt
1-27	.10	150 KΩ 1/2 watt
1-33	.10	470 KΩ 1/2 watt
2-159	.20	100 Ω precision
2-25	.20	216.2 Ω precision
2-28	.20	683.8 Ω precision
2-31	.20	2162 Ω precision
2-33	.25	6838 Ω precision
2-39	.20	21.62 KΩ precision
2-17	.50	10 megohm precision
2-50	.20	10 KΩ precision
CAPACITORS		
20-71	.35	.0013 μfd mica (1300 μμf)
20-75	.80	.005 μfd mica (5000 μμf)
21-47	.10	.01 μfd disc ceramic
21-31	.10	.02 μfd disc ceramic
23-28	.20	.1 μfd tubular
27-19	1.65	1 μfd Mylar
25-39	.50	2 μfd 150 volt electrolytic
25-95	.55	10 μfd electrolytic, 25 volts
25-23	1.20	20-40-80 μfd electrolytic, 150 volts
31-13	.90	3-12 μμf trimmer
CONTROL-SWITCH-TRANSFORMER		
11-16	1.15	40 Ω control
63-502	4.15	Range switch, 11-position
54-2-24	3.10	Power transformer

PART No.	PRICE Each	DESCRIPTION
BINDING POSTS-TERMINALS		
70-5	.10	Banana plug sleeve, black
70-6	.10	Banana plug sleeve, red
75-17	.10	Binding post insulator
100-16-2	.10	Binding post cap, black
100-16-18	.10	Binding post cap, red
427-3	.15	Binding post base
431-5	.10	4-lug terminal strip
431-12	.10	4-lug terminal strip
431-14	.10	2-lug terminal strip
431-16	.10	2-lug terminal strip
431-40	.10	4-lug terminal strip
431-51	.10	1-lug terminal strip
438-13	.15	Banana plug
HARDWARE		
250-56	.05	6-32 x 1/4" screw
250-48	.05	6-32 x 1/2" screw
250-49	.05	3-48 x 1/4" screw
250-83	.05	#10 x 1/2" handle screw
250-89	.05	6-32 x 3/8" screw
252-1	.05	3-48 nut
252-3	.05	6-32 nut
252-7	.05	Control nut
440-11	.10	Plastic control guard
252-22	.05	6-32 speednut
253-10	.05	Flat control washer
254-1	.05	#6 lockwasher
254-4	.05	Control lockwasher
254-7	.05	#3 lockwasher
255-17	.10	6-32 tapped spacer
259-1	.05	#6 solder lug
259-10	.05	Control solder lug
260-1	.10	Alligator clip
WIRE-SLEEVING		
89-23	.75	Line cord
340-8	.05/ft	Bare wire
341-1	.05/ft	Black test lead
341-2	.05/ft	Red test lead
344-59	.05/ft	Hookup wire
346-1	.05/ft	Sleeving
346-6	.05/ft	3/8" sleeving
347-9	.10/ft	3-conductor shielded cable



NOTES:

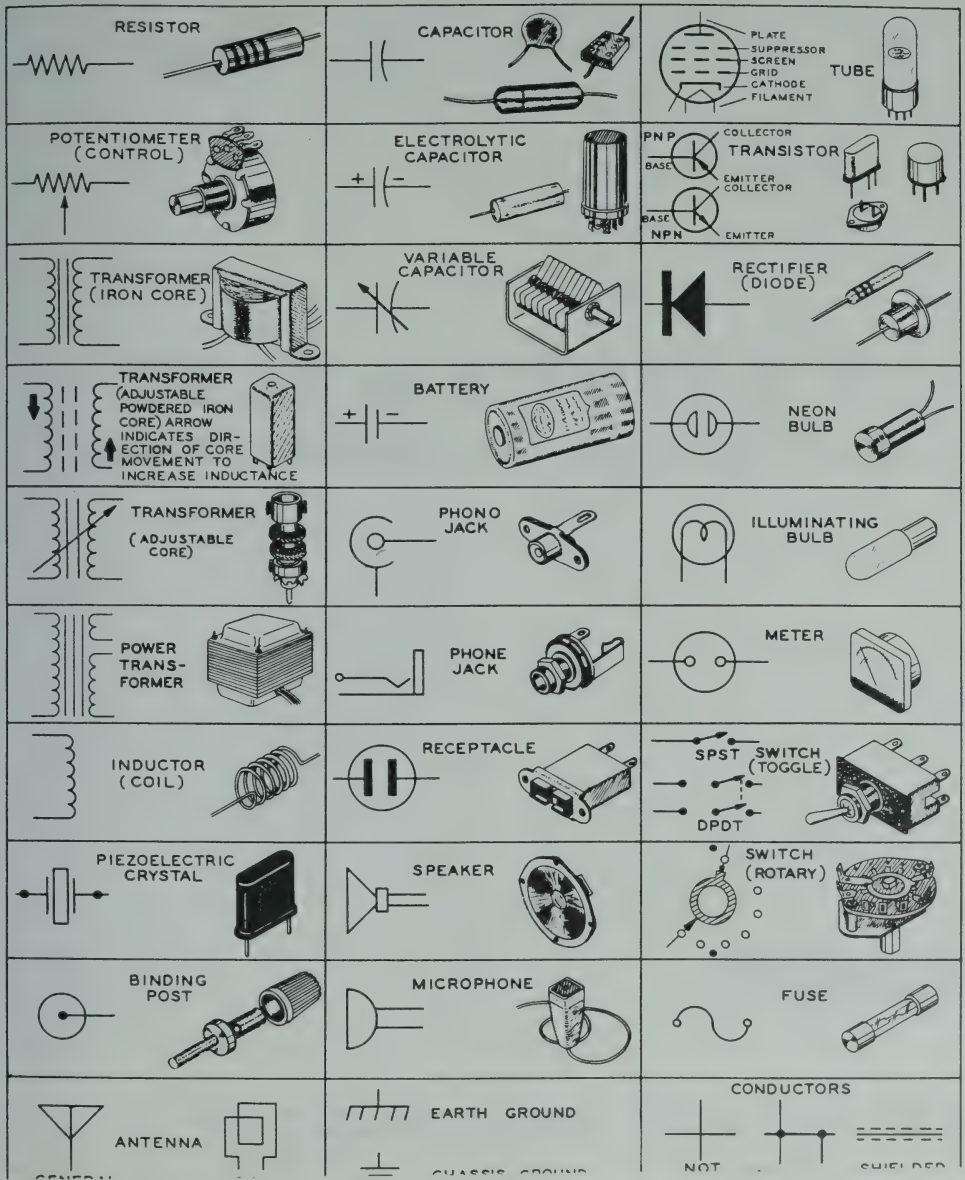
ALL RESISTORS ARE 1/2 WATT.
ALL RESISTOR VALUES ARE IN Ω, 1 K = 1000 Ω, 1 MEG = 1,000,000 Ω.
ALL CAPACITOR VALUES ARE IN μfd UNLESS SHOWN OTHERWISE.

ALL VOLTAGES ARE FROM POINT INDICATED TO CHASSIS GROUND EXCEPT AC VOLTAGES ON POWER TRANSFORMER WINDINGS. READINGS WERE TAKEN WITH AN 11 MEGOHM INPUT VTVM.

VOLTAGES WERE TAKEN WITH INPUT TERMINALS SHORTED AND RANGE SWITCH IN 300 V POSITION.

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



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AUDIO

MODEL IM-28

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PART No.	PRICE Each	DESCRIPTION
TUBES-LAMP-SOCKETS		
411-96	1.80	6AW8 tube
411-160	1.80	6EJ7/EF184 tube
412-1	.15	#47 lamp
434-43	.20	9-pin tube socket
434-44	.15	Pilot lamp socket
SHEET METAL PARTS		
200-309	.50	Top chassis
200-310	.65	Bottom chassis
203-105-3	.90	Front panel
205-603	.45	Back plate
206-179	.15	Switch shield
90-413	3.50	Cabinet
MISCELLANEOUS		
56-26	.25	Crystal diode
57-27	.50	Silicon rectifier
73-1	.10	Rubber grommet
206-54	.30	9-pin tube shield
211-15	.20	Handle
75-71	.10	Strain relief, flat cord
75-30	.10	Strain relief, round cord

PART No.	PRICE Each	DESCRIPTION
Miscellaneous (cont'd.)		
432-27	.40	Line cord adapter
455-50	.10	Knob bushing
490-5	.10	Nut starter
261-4	.05	Rubber foot
407-85	11.40	Meter
462-245	.25	Knob
481-1	.10	Capacitor mounting wafer
331-6	.15	Solder
	2.00	Manual (See front cover for part number.)

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and observe the following shipping instructions:

Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan 49022.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

TION

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ug sleeve, red
ost insulator
ost cap, black
ost cap, red
ost base
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minal strip
minal strip
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2" screw
1" screw
/2" handle screw
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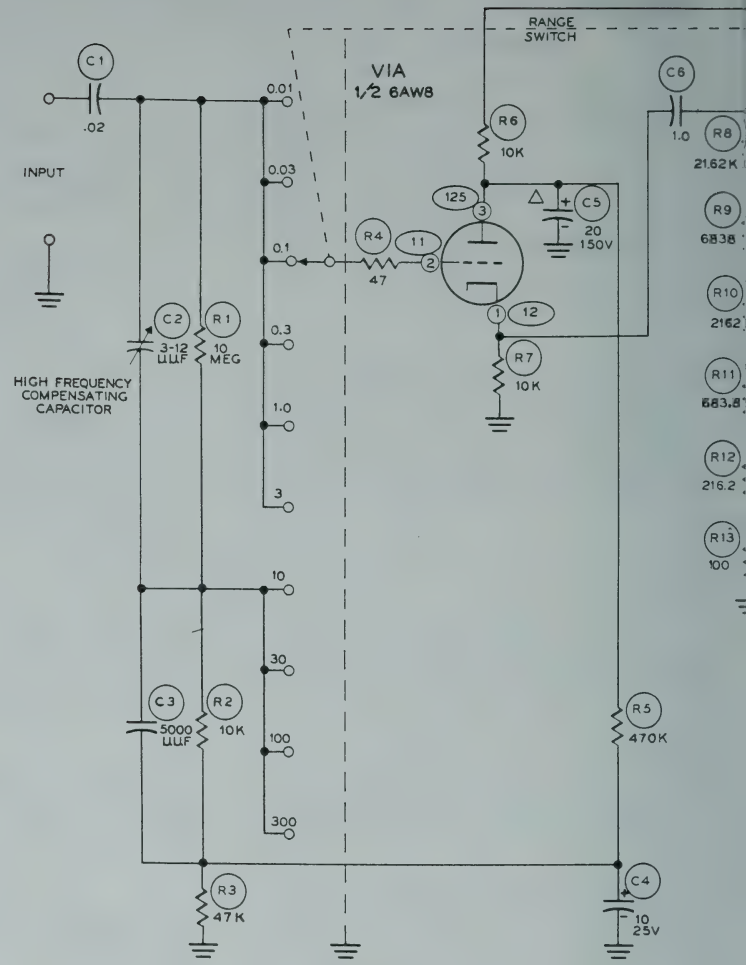


HEATHKIT

AC VACUUM TUBE VOLTMETER
MODEL IM-38

CIRCUIT IMPEDANCES

Circuit impedances should be considered when comparing one db level to another. An example of this could be where the gain of an amplifier is being measured. If the input impedance is the same as the output impedance, the db gain can be measured directly with the VTVM. If the input and output impedances are different, it is necessary to adjust each reading mathematically to a common reference level.

VU APPLICATIONS

Because of the VU-type ballistics (rapid action) of the meter movement, the VTVM can be used to indicate changing AC voltages such as those that occur in speech or music. This enables you to use the VTVM to monitor audio signals, such as the input to a tape recorder in order to insure proper recording level.

BIBLIOGRAPHY

Langford-Smith, RADIOTRON DESIGNERS HANDBOOK, 4th Edition, Chapter 19, Published by RCA.

Rider, J. F., VACUUM TUBE VOLTMETER, 2nd Edition.

Turner, BASIC ELECTRONIC TEST INSTRUMENTS, Rinehart, 1953.

HEWLETT-PACKARD Journal, ARTICLES ON WAVEFORM, April-May-June 1955, Vol. 6, Numbers 8, 9, and 10.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of this manual.

3. Check to be sure that both tubes are in their proper locations. Make sure that they light up properly.

4. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.

5. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

6. Check the tubes with a tube tester or by substitution of tubes of the same types which are known to be good.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with an 11 megohm input vacuum tube voltmeter. Voltages may vary as much as 10% due to line voltage variations. Larger variations may lead you to the cause of the trouble.

8. A review of the Circuit Description will prove helpful in indicating where to look for the cause of the trouble.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the Service and Warranty sections of the "Kit Builders Guide", and to the "Factory Repair Service" information on fold-out from Page 28 of this Manual.

OPERATION

The OFF position of the Range switch is just above the highest voltage range. This protects the instrument by insuring that it is always turned to the highest voltage range when first turned on. On the lower ranges, the meter may indicate some voltage when no connections are made to the input terminals. This residual voltage is caused by the extreme sensitivity of the instrument. Reverse the AC line plug to determine which way gives the lowest residual voltage.

The Range switch positions cover the 300, 100, 30, 10, 3, 1, .3, .1, .03, and .01 volt ranges. The meter scale is marked 0-3 and 0-10 for voltage measurements. Be sure to place the decimal in the proper place in order to indicate the correct voltage for each range.

Example 1: Using the .03 range, the meter reads 2. Move the decimal point two places to the left for the correct voltage; in this case .02 volt.

Example 2: The meter reads 6.4 on the .1 volt range. Move the decimal point two places to the left for the correct voltage; in this case .064 volt.

The decibel (db) scales range from -40 db to +50 db. When reading the db scale, add the meter reading to the range indication.

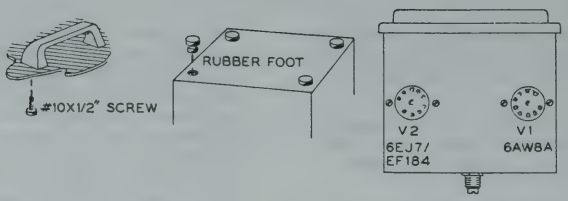
Example 1: The meter indicates -5 db and the range switch is on the +20 db range; the actual value is +15 db.

Example 2: The meter indicates -4 db and the range switch is turned to the -10 db position; the actual value is -14 db.

Do not touch the input terminals when the range switch is set to one of the low ranges. Stray electric fields picked up by the human body will deflect the pointer beyond full scale, causing the meter pointer to bang against the limit pin. Repeated extreme overloads could bend the pointer.

Although the pointer can be bent by repeated extreme overloads, the electronic circuit limits the signal applied to the meter to a safe value, thus protecting the coil windings of the meter from being damaged. NOTE: Occasionally, switching transients will cause the meter to deflect to full scale when switching from one range to another. These transients are normal, and will not harm the meter.

CAUTION: The circuit ground and the case of this instrument are both connected to the power line ground through the green line cord wire. Excepting power line measurements, always connect the Ground test lead of this VTVM to the chassis, or circuit ground, of the device being tested or measured.



PICTORIAL 8

Refer to Pictorial 8 for the following steps.

( ) Install the handle at the top of the cabinet, using the two #10 x 1/2" handle screws.

( ) Install the four rubber feet in the four holes on the bottom of the cabinet.

( ) Install the tubes in their sockets; V1-6AW8, V2-6EJ7/EF184. Install a tube shield on each tube socket.

( ) Strip both ends of the lengths of black and red test lead. Prepare each of the test leads as shown in Figure 1.

( ) Fasten an alligator clip at one end of the red test lead. Install the red banana plug sleeve over the other end with the threaded end of the sleeve facing outward.

( ) Fasten the banana plug on the end of the test lead, and screw the banana plug sleeve onto the banana plug.

( ) Prepare the black test lead in the same manner.

Your VTVM is now ready for calibration.

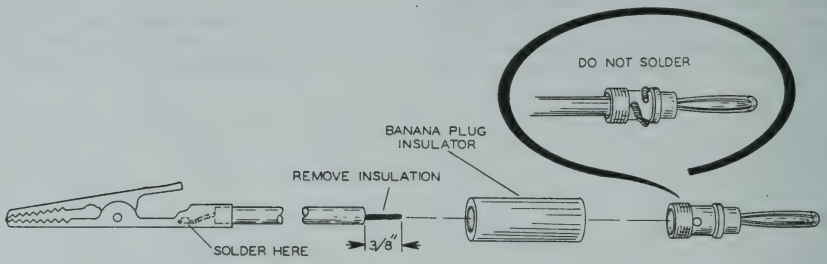


Figure 1

SPECIFICATIONS

Frequency Response	±1 db from 10 cps to 500 kc, all ranges. ±2 db from 10 cps to 1 mc, all ranges.
Ranges	Ten ranges, marked both in volts and db.
Volts	.01, .03, .1, .3, 1, 3, 10, 30, 100, 300 volts rms full scale.
Decibels	-40, -30, -20, -10, 0, +10, +20, +30, +40, +50 db (0 db is equal to 1 milliwatt in 600 Ω).
Input Impedance	10 megohms shunted by 12 $\mu\mu$f on all ranges from 10 volts to 300 volts.
	10 megohms shunted by 22 $\mu\mu$f on all ranges from .01 volt to 3 volts.
Power Requirements	105-125 or 210-250 volts, 50/60 cps AC, 10 watts.
Dimensions	7-3/8" high x 4-11/16" wide x 4-1/8" deep.
Accuracy	Within 5% of full scale.
Net Weight	3 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

INTRODUCTION

The Model IM-38 Vacuum Tube Voltmeter is designed to measure AC voltages from 10 cycles per second to 1 megacycle. Ten switch-selected voltage ranges are provided. The full-scale readings vary from 10 millivolts for the lowest range to 300 volts for the highest. Each of these ten ranges is also calibrated in db (decibels) for your convenience.

A high input impedance (10 megohms) is provided so that the VTVM can be used to measure voltages in sensitive circuits without appreciable loading.

The VTVM normally is used to indicate repetitive AC voltages. It can also be used as a VU meter to indicate changing AC voltages, such as found in speech or music equipment. (The VU meter is a standard level meter used in broadcasting and recording equipment.)

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

Dear Customer:

You have just purchased one of the best performing electronic products in the world — your Heathkit.

Here's how we aim to keep it that way:

Your Heathkit Warranty

During your first 90 days of ownership, any parts which we find are defective, either in materials or workmanship, will be replaced or repaired free of charge. And we'll pay shipping charges to get those parts to you — anywhere in the world.

If we determine a defective part has caused your Heathkit to need other repair, through no fault of yours, we will service it free — at the factory, at any retail Heathkit Electronic Center, or through any of our authorized overseas distributors.

This protection is exclusively yours as the original purchaser. Naturally, it doesn't cover damage by use of acid-core solder, incorrect assembly, misuse, fire, flood or acts of God. But, it does insure the performance of your Heathkit anywhere in the world — for most any other reason.

After-Warranty Service

What happens after warranty? We won't let you down. If your Heathkit needs repairs or you need a part, just write or call the factory, your nearest retail Heathkit Electronic Center, or any Heath authorized overseas distributor. We maintain an inventory of replacement parts for each Heathkit model at most locations — even for models that no longer appear in our current product line-up. Repair service and technical consultation is available through all locations.

We hope you'll never need our repair or replacement services, but it's nice to know you're protected anyway — and that cheerful help is nearby.

Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022

HEATH COMPANY

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